ZES ZIMMER

Sensors & Accessories

for LMG Family

User Manual

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1 Introduction

1.1 Used symbols

This manual describes and explains symbols which are found here and displayed on the equipment. Observation of these warning signs is required for safe operation.

Electric shock
This symbol indicates danger of injury or death from electric shock due to dangerous voltages. *Do not touch. Use extreme caution.*
AC voltages over 33 V RMS, 46.7 V peak and DC voltages over 70 V are deemed to be hazardous live according to IEC 61010 resp. EN 61010. There is a danger of electric shock. This can cause death or injury to body or health. Furthermore, there is a risk of material damages.

High temperature
This symbol indicates a high temperature. There is a burn and fire hazard. There is a danger of fire or injury to body or health due to hot surfaces or material. Furthermore, there can be material damages to other objects due to contact or close proximity. If a burn or fire does occur, there can be further damages which can cause death or injury to body or health.

Caution
This symbol indicates the risk of damages to persons or material. Also if material damages occur, there can be further damages which can cause death or injury to body or health.
This symbol on the equipment indicates that this user manual is to be consulted for instruction or further information provided in order for save operation.

Information
This symbol indicates facts or information regarding the equipment which should be observed for easy and accurate operation.

Protective conductor terminal
This symbol indicates the terminal for the protective conductor. See also Connection to power supply and protective conductor [1.2.1→7].

References/links
References to tables, figures, listings, etc. consist of their identifier followed by the book symbol and the page number.
References to chapters, sections, and subsections consist of the heading of the section and the sectional number followed by the book symbol and the page number.

[→5]

Used symbols [1.1→5]

In the PDF version of this document, one can click on any of these reference elements to jump to the reference.

1.2 Safety recommendations

This equipment was designed according to IEC 61010 and EN 61010 and has left the factory in a mechanically and electrically safe condition. To maintain safe operation, the user must follow the instructions and warnings contained in this manual. The equipment must only be used for the purposes described in this manual.

If damage to the equipment is suspected, it must be removed from operation to prevent possible further damages or injury. In addition the required repair work must be carried out by a trained technician at a suitable repair facility.

Until shown to be otherwise, the equipment must be considered unsafe to operate if

- there is visual evidence of physical damage,

- it fails to operate correctly,
- the equipment has been heavily overloaded due to to high currents (short circuit or something similar),
- the equipment has been heavily overloaded due to to high voltages,
- the equipment has been operated with supply voltage outside specifications,
- there are loose parts inside the equipment,
- long term storage has taken place in conditions outside the stated specifications for safe storage,
- condensation is present, or
- rough transport has occurred.

The intended use of this equipment (within the limitations stated in the the technical data) is to measure electrical current and/or voltage.

When handling electricity and/or an electrical apparatus, be sure to observe all safety rules. These rules include, but are not limited to, the following:

- Opening the equipment exposes components which are under high voltage. *This is only permitted to trained personnel. User risks injury by removing cover and may void any manufacturer's warranty.* All voltage sources must be disconnected from the equipment before any equipment covers are removed. Only suitably qualified personnel are permitted such access for the purpose of calibration, service, repair or changing of components.
  If the equipment has been opened, a high voltage test and a test of the protective conductor are necessary according EN 61010 following the closing of the equipment for safety purposes prior to use.

- Fuses may only be replaced with the correctly rated and recommended types as written in this manual. Reading the rated values from the fuse to be replaced is not permitted. The use of repaired, short-circuited or insufficient fuses is not permitted.

- The environmental conditions (see General environmental conditions [1.3→9]) must be observed to ensure safe operation of the equipment.
  Use in any type of wet or explosive environment or in presence of flammable gases or liquids is especially prohibited.

- The equipment and accessories (such as wires and clips) must be checked before each use. Defective parts must be replaced.

- Ventilation openings must be kept clear (see General environmental conditions [1.3→9]) to guarantee the required air flow and to prevent overheating of the equipment. In the same way, the air filter at the air inlets must be clean to permit sufficient air flow. Do not operate the equipment without air filter or the filter holder as injury may result.
  Especially take care that the equipment is not placed above sheets of paper which could get sucked into the ventilation openings at the bottom of the equipment!
  When mounting the equipment into a rack, make sure that the slide rails do not cover any ventilation openings.

- The equipment must not be used in a medical environment nor in any other environment that may have a potential effect on life or health.

- Impacts or rough handling may damage the equipment. Do not place heavy objects on the equipment.

- If the weight of the equipment is too heavy to be carried by one person, carry the equipment with two persons and/or use an appropriate tool. In all cases, use the handles and grips of the equipment to lift and carry it safely.

- The equipment is *not* designed to detect hazards or similar! A wrong reading (e.g. by choosing a wrong filter or range) could give you the wrong impression of a safe state. Use appropriate tools (e.g. a voltage detector) instead of this equipment to detect dangerous situations.

- Be careful when connecting external equipment like an external keyboard or mouse to an instrument. They might not be designed to operate in the same EMC environment as the instrument and therefore they could be disturbed. This could lead to unwanted operation of the instrument like changing ranges or something similar.

- When connecting the instrument watch the order of connections: First connect it to the protective conductor and the power supply (see CONNECTION TO POWER SUPPLY AND PROTECTIVE CONDUCTOR [1.2.1→7]), then connect it to the measurement circuit (see CONNECTION TO MEASUREMENT CIRCUIT [1.2.2→8]). Then switch on the instrument and the equipment, and finally, after double checking the wiring, switch on the measurement circuit.

- This equipment was designed according to IEC 61010 and EN 61010 which are general safety standards for equipment for measurement, control and laboratory use. In a concrete application or environment further safety standards might be applicable and have to be regarded in addition.

1.2.1 Connection to power supply and protective conductor

- Before connecting the mains cable to the power supply, confirm that the mains supply voltage corresponds to the voltage printed on the model's identification plate. If a voltage selector switch exists, it must be set appropriately. A suitable power source has to be used to operate the equipment/instrument.

- The mains plug may only be inserted into a mains power supply socket with protective earth contact. This protection must not be disabled by the usage of plugs, cables or extension cords without protective earth.
  The mains plug must be inserted into the mains socket *before* any other connections are made to the equipment/instrument. Any kind of interruption of the protective earth, inside or outside the equipment/instrument, or disconnecting the protective earth connector can result in an unsafe condition of the equipment/instrument and is not allowed. The usage of cables, plugs, sockets or adapters with only two poles, prongs or connectors is not allowed.

  The *additional* protective conductor terminal of the equipment/instrument chassis must be used for the case where an earth current in excess of 10 A might result accidentally from the circuit under test.

> *Such currents are too large for the earthing connection of the equipment/instrument's supply cord. In case of a single fault, the protective conductor might not be able to carry this current. If it would be interrupted, the case would no longer be protected against electric shock!*

  In this case, connect the additional protective conductor terminal with an adequately rated cable to a suitable earthing point. The additional protective conductor terminal is limited to currents up to 32 A.

  If reliable earthing cannot be realized, the connections between the circuit under test and the equipment/instrument must be fused appropriately.

  The earth terminal on the equipment/instrument must not be used as the only earth connection for the equipment/instrument nor must the circuit under test nor any other equipment/instrument be earthed by this terminal. The additional protective conductor is marked with following symbol:

1.2.2 Connection to measurement circuit

- Remove all energy sources from the measurement circuit before making any connections between this circuit and the analyzer. Do not connect or disconnect any cables while they are carrying voltage relative to earth.

- Use only measurement cables with safety connectors and sufficient cross section. Be sure that the cables have a sufficient voltage and current rating and are usable for the desired overvoltage and measurement category.

> *Cables not having safety but standard connectors might have insufficient clearance and creepage distances, even if they are plugged into the socket. So there is always a risk of an electric shock.*

  Use only colored cables which match to the color of the jack to help prevent a wrong connection.

  When connecting the measurement circuit, take special care not to connect the voltage wires to the current input of the equipment/instrument. When switching the measurement circuit on, this would result in a short circuit which risks damage to the analyzer and to the user!

> *Such short circuits can be very dangerous, as currents of several thousand amperes might flow during the short circuit!*

  For the connection of the *voltage* measurement circuit to the equipment/instrument use *only* cables with suitable fuses, like those delivered together with the equipment/instrument.

> *The fuses in the voltage measurement cables will interrupt the current flow in case that these cables are accidentally inserted into the low ohmic current measurement jacks. Therefore short circuiting of a high power source (e.g. the output of an energy distribution transformer) will not cause any hazard.*

  The yellow and black voltage cables have each an implemented fuse. Before and after each measurement: Check the fuse! To replace this fuse, remove the cable on both sides from all circuits to make it free of dangerous voltages. Unscrew the fuse holder. Replace the fuse only with following type:

  6.3x32 mm, FF 500 mA, 1000 V, AC+DC, 30 kA breaking capacity

  Screw the fuse holder together again.

- When connecting to high power measurement circuits (e.g. the output of an energy distribution transformer), massive damage could occur when mismatching cables, short-circuiting the measurement circuit, or using the current jacks of the equipment/instrument instead of the voltage jacks and similar. So it is recommended to use appropriate fuses in *all* measurement cables. When selecting a fuse, ensure that at least the following properties are met:
  - The usual measuring current must flow without interruption (rated current of the fuse)
  - The short circuit current of the measurement circuit must be interrupted safely (breaking capacity of the fuse)
  - The maximum voltage of the measurement circuit must be interrupted safely (rated voltage of the fuse)
  - The fuse must be suitable for the type of current: AC, DC or both (breaking capacity of the fuse)
  - The fuse must be fast enough to protect the cables and the equipment/instrument

- The maximum voltages between the voltage jacks may not exceed the technical specifications.

- The maximum currents at the current jacks may not exceed the technical specifications.

- The maximum voltages of the jacks against earth may not exceed the technical specifications.

- External current sensors or transformers must be connected to wires and jacks which have a ten times higher overload capability, only. If the cables or jacks are not sufficient they could be interrupted in case of overload! For the same reason it is *not* allowed to use fuses in this current measurement wires.

  Before using jacks, test if they have a low impedance current path to prevent high voltages at the output of the external device.

  > *In general, it is dangerous to interrupt the secondary side of a current transformer as there might appear very high voltages which could lead to electric shock.*

- Cables from/to external sensors are usually designed to operate with low voltages (e.g <15 V). When using these in an environment with a high voltage circuit, use caution as further isolation might be necessary. For the operation itself the isolation is sufficient, but if these cables touch a bare conductor with dangerous voltages this can cause an unsafe condition! In such cases, further isolation might be necessary.

  For example, the secondary cables of a current clamp have a very low voltage, but they could touch the current bar which has a dangerous voltage against earth.

- Especially when establishing external connections, special care must be taken to prevent electrostatic discharge.

- Different sensors might require different connection cables to the instrument. When changing a sensor, please ensure that a correct cable is used. Usually the cable is dedicated to a sensor.

- Keep away from energized measurement circuits to prevent electric shock. When performing measurements on installations or circuits, please observe all safety regulations and guidelines. In particular, only suitable measurement accessories should be used. Only suitably qualified personnel are permitted to work with energized measurement circuits.

- When you put the equipment/instrument out of operation, all external cables shall be removed. Special care has to be taken when disconnecting current sensors. Before interrupting their secondary current, the primary current has to be switched off. After disconnecting, the secondary side of the current sensors has to be short-circuited to prevent dangerous voltages.

1.3 General environmental conditions

The general environmental conditions, *except limited or extended by a specific sensor*, are:

- Indoor use only
- Altitude up to 2000 m
- Temperature +5 °C … +40 °C
- Maximum relative humidity 80 % for temperatures up to +31 °C decreasing linearly to 50 % relative humidity at +40 °C
- Mains supply voltage fluctuations up to ±10 % of the nominal voltage
- Transient overvoltages up to the levels of overvoltage category II, i.e. to be supplied from a power outlet of the building wiring
- Temporary overvoltages occurring on the mains supply
- Pollution degree 2, i.e. only non-conductive pollution occurs except that occasionally a temporary conductivity caused by condensation is expected

1.4 Technical assistance

For technical assistance you can contact the supplier of the equipment/instrument or the manufacturer:

ZES ZIMMER Electronic Systems GmbH
Tabaksmühlenweg 30
D-61440 Oberursel
Germany
Phone: +49 (0)6171/628750
Fax: +49 (0)6171/52086
Email: sales@zes.com
URL: http://www.zes.com

2 Current Sensors

2.1 Precision current transducer 200 A (PCT200)

Figure 2.1: PCT200

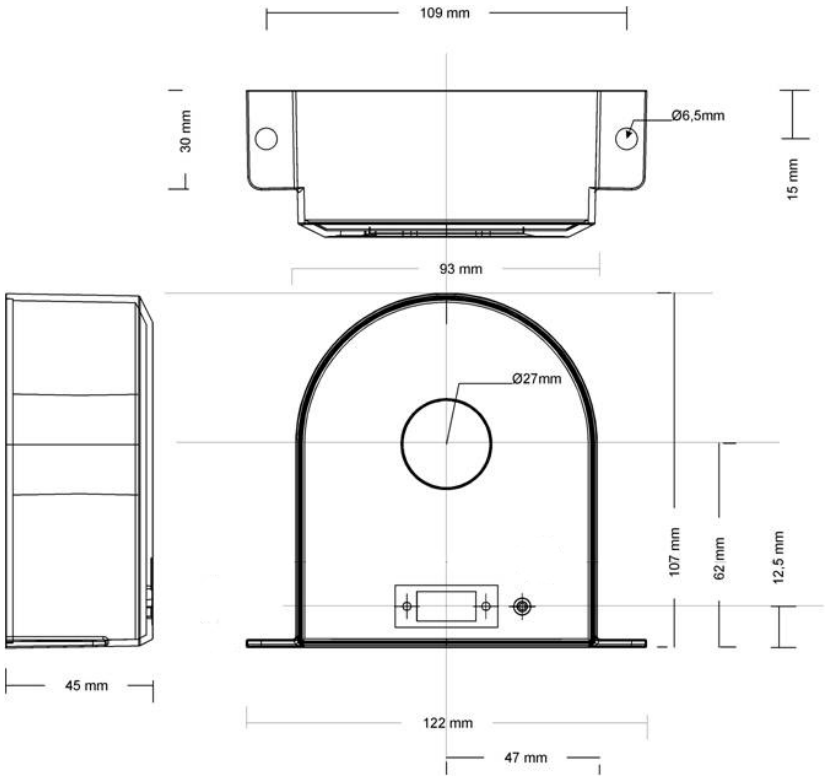

Figure 2.2: PCT200 mechanical dimensions

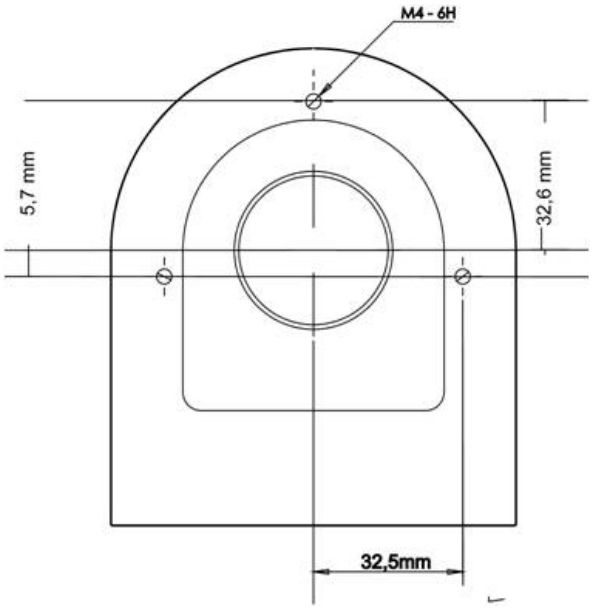

Figure 2.3: PCT200 mounting bushings on the back, maximum screw depth 6 mm

2.1.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter Safety recommendations [1.2→5]!

2.1.2 Specifications

Nominal input current rms	200 A
Maximum input current rms	300 A
Maximum input current peak	300 A
Transformation ratio	500:1
Maximum input overload	1500 A, 100 ms, normal operation after overload 1500 A, 10 s, Sensor shut down but not damaged
Bandwidth	1 MHz
Burden	0 ... 3 Ω
Safety standard	EN 61010-1
Rated isolation voltage rms, reinforced isolation	500 V CAT II, pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 3.6 kV 200 V
Impulse withstand voltage	9 kV
Creepage distance	10 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +65 °C (-40 °C ... +85 °C @ input current rms ≤ 200 A
Storage temperature	-40 °C ... +85 °C
Weight	0.6 kg
Supply	±(15 V±0.75 V) 700 mA
EMC	EN 61326

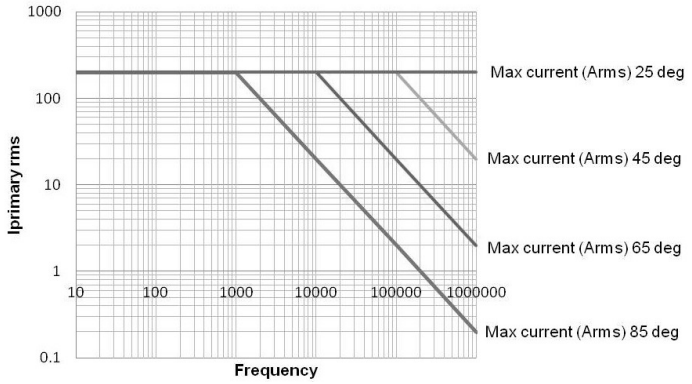

Figure 2.4: PCT200 temperature derating

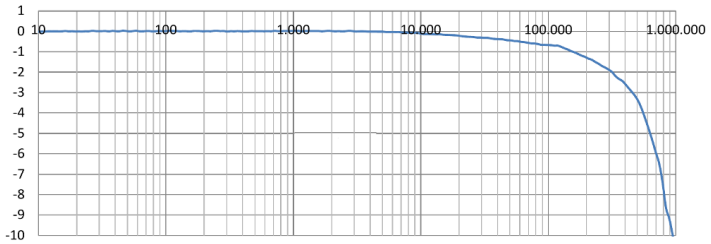

Figure 2.5: PCT200 typical gain error vs. frequency

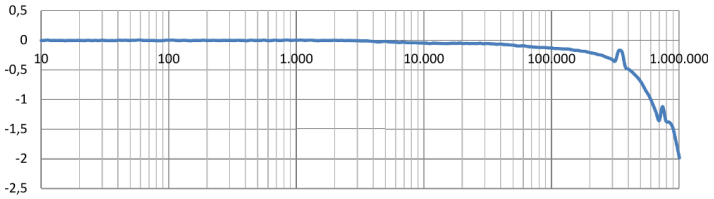

Figure 2.6: PCT200 typical phase error vs. frequency

2.1.3 DSUB9 connector pin assignment of PCT200

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.1.4 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety

ground on the product, for safety reasons the transducer head PCT200 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT200 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT200 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT200-K-L6' and optionally the elongation cable 'LMG-Z-SVTxx' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT200 and PCTSIU4.

Also if bare conductors can be used up to the above values, it is strictly recommended to use isolated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

2.1.5 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Amlitude uncertainty in % of nominal input current rms	Phase uncertainty
DC ... 5 kHz	±0.01 %	±0.1 °
5 kHz ... 100 kHz	±1 %	±0.5 °
100 kHz ... 1 MHz	±20 %	±5 °

Temperature coefficient ±0.1 ppm/°C of maximum input current peak in the temperature range of -40 °C ... +85 °C .

See specification of the LMG connection cable for the LMG measuring ranges and to calculate the accuracy of the complete system.

2.1.6 Sensor without supply or open secondary circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current (less than 10 ppm).

2.1.7 Connection of the sensor PCT200 with LMG600

Use PCT200-K-L6 and L60-X-ADSE, supply via LMG600.

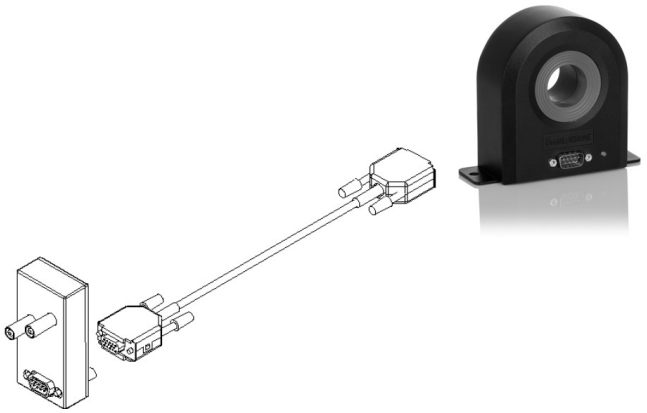

Figure 2.7: PCT200 and PCT200-K-L6 and L60-X-ADSE

This cable 'PCT200-K-L6' is used to connect the precision current transducer PCT200 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT200 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Connection

- switch all power off
- plug the connector labeled 'PCT200' to the sensor
- plug the connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with PCT200

Nominal range / A	2.5	5	10	20	40	75	150	200
Max. TRMS value / A	2.75	5.5	11	22	44	82.5	165	300
Max. peak value / A	7	14	28	56	112	234.5	300	300
Range peak value for accuracy calculation / A	7	14	28	56	112	234.5	469	937.5

Accuracy

Use PCT200 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.1.8 Connection of the sensor PCT200 with PCTSIU4

For the use of PCT200 with other instruments with current input and supply via PCTSIU4. Connect PCT200 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.1.9 Connection of the sensor PCT200 with SSU4

It is not recommended for new projects, but the sensor supply unit SSU4 can be used with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.1.10 Connection of the sensor PCT200 with LMG95

Use PSU/PCT-K-L95, supply via LMG95, no additional error terms.

2.1.11 Connection of the sensor PCT200 with LMG450

Use PCT200-K-L45 and SSU4 (standard version).

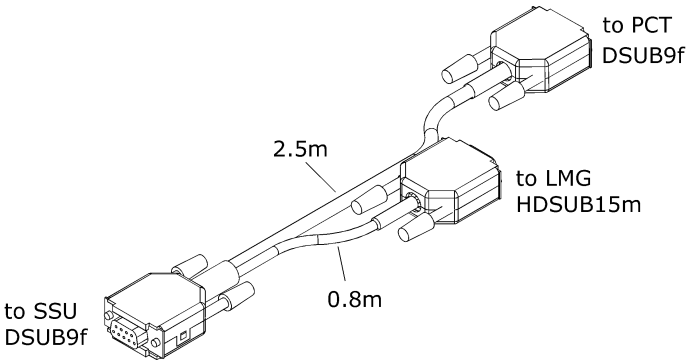

Figure 2.8: PCT200-K-L45

This cable 'PCT200-K-L45' is used to connect a precision current sensor PCT200 to the power meter LMG450 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG450 contains the adjustment data of the PCT200 head as well as the serial number. The rangenames of LMG450, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG450 with PCT200

Nominal range / A	6.25	12.5	25	50	100	200
Max. TRMS value / A	8.3125	16.625	33.25	66.5	133	266
Max. peak value / A	9.375	18.75	37.5	75	150	300

Accuracy

Use PCT200 and LMG450 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±30 mA DC offset tolerance.

2.1.12 Connection of the sensor PCT200 with LMG500

Use PCT200-K-L50 and L50-Z14, supply via LMG500.

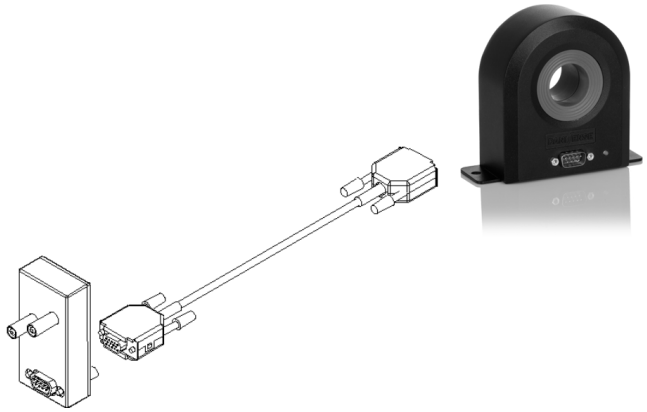

Figure 2.9: PCT200 and PCT200-K-L50 and L50-Z14

This cable 'PCT200-K-L50' is used to connect a precision current sensor PCT200 to the power meter LMG500 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG500 contains the adjustment data of the PCT200 head as well as the serial number. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG500 with PCT200

Nominal range / A	1.5	3	6	12.5	25	50	100	200
Max. TRMS value / A	2.078	4.156	8.3125	16.625	33.25	66.5	133	266
Max. peak value / A	2.344	4.688	9.375	18.75	37.5	75	150	300

Accuracy
Use PCT200 and LMG500 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±30 mA DC offset tolerance.

2.1.13 Connection elongation

To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extention cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES ZIMMER: 'LMG-Z-SVTxx' or 'LMG-Z-DV' in different lenths from 5m to 50m. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.2 Precision current transducer 600 A (PCT600)

Figure 2.10: PCT600

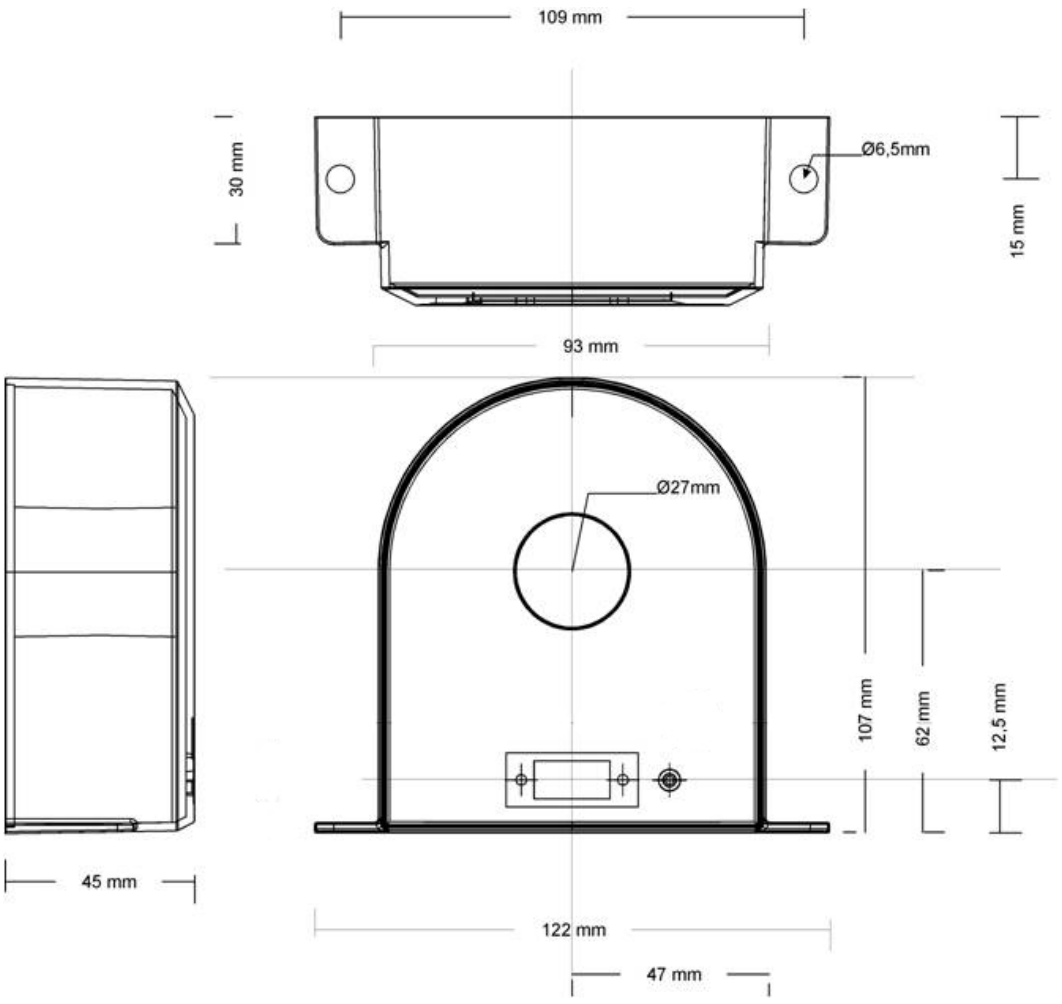

Figure 2.11: PCT600 mechanical dimensions

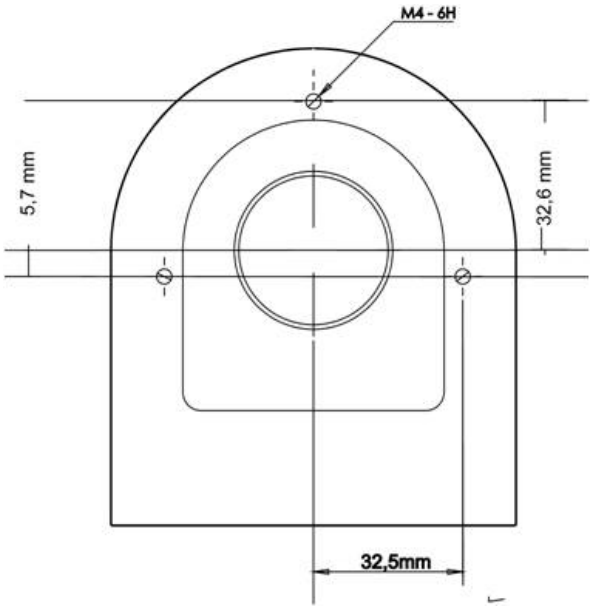

Figure 2.12: PCT600 mounting bushings on the back, maximum screw depth 6 mm

2.2.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.2.2 Specifications

Nominal input current rms	600 A
Maximum input current rms	900 A
Maximum input current peak	900 A
Transformation ratio	1500:1
Maximum input overload	4500 A, 100 ms, normal operation after overload 4500 A, 10 s, Sensor shut down but not damaged
Bandwidth	100 kHz
Burden	0 ... 3 Ω
Safety standard	EN 61010-1
Rated isolation voltage rms, reinforced isolation	500 V CAT II, pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 3.6 kV 200 V
Impulse withstand voltage	9 kV
Creepage distance	10 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +65 °C (-40 °C ... +85 °C @ input current rms ≤ 600 A)
Storage temperature	-40 °C ... +85 °C
Weight	0.6 kg
Supply	±(15 V±0.75 V) 700 mA
EMC	EN 61326

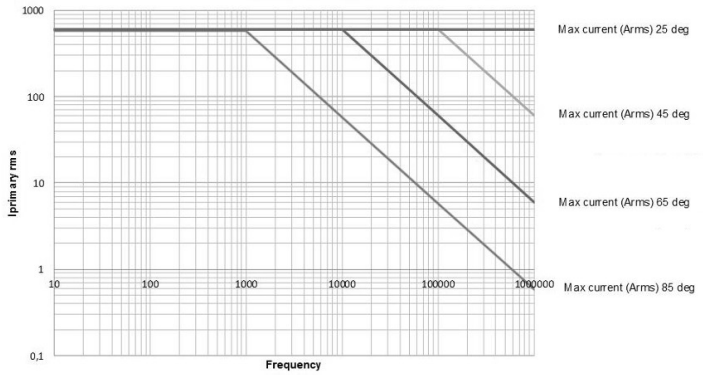

Figure 2.13: PCT600 temperature derating

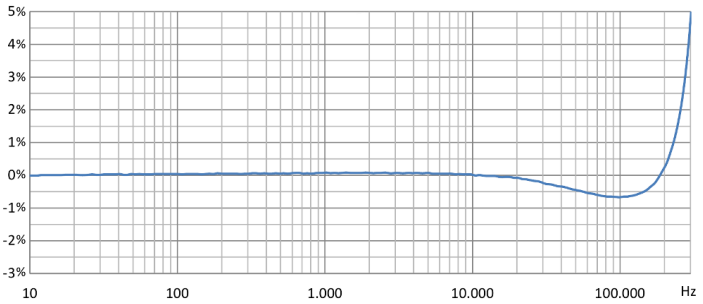

Figure 2.14: PCT600 typical gain error

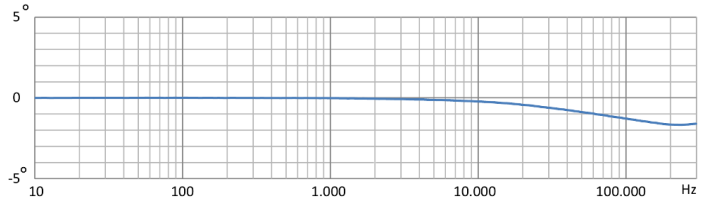

Figure 2.15: PCT600 typical phase error

2.2.3 DSUB9 connector pin assignment of PCT600

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.2.4 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT600 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT600 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT600 is also recommended to lead away capacitive coupled distortion.

For LMG600 use the connection cable 'PCT600-K-L6' and optionally the elongation cable 'LMG-Z-SVTxx' or 'LMG-Z-DV'. For other instruments use the supply unit PCTSIU4 together with the connection cable PCT-DSUB between PCT600 and PCTSIU4.

Also if bare conductors can be used up to the above values, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Use LMG connection cable and PCT with corresponding serial numbers!

2.2.5 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Amlitude uncertainty in % of nominal input current rms	Phase uncertainty
DC ... 2 kHz	±0.01 %	±0.1 °
2 kHz ... 10 kHz	±0.5 %	±0.5 °
10 kHz ... 100 kHz	±3 %	±3 °

Temperature coefficient ±0.1 ppm/°C of maximum input current peak in the temperature range of -40 °C ... +85 °C .

See specification of the LMG connection cable for the LMG measuring ranges and to calculate the accuracy of the complete system.

2.2.6 Sensor without supply or open secondary circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current (less than 10 ppm).

2.2.7 Connection of the sensor PCT600 with LMG600

Use PCT600-K-L6 and L60-X-ADSE, supply via LMG600.

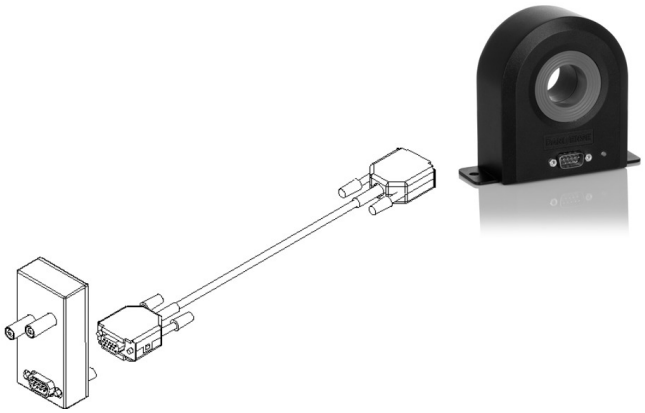

Figure 2.16: PCT600 and PCT600-K-L6 and L60-X-ADSE

This cable 'PCT600-K-L6' is used to connect the precision current transducer PCT600 to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the PCT600 head as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Connection

- switch all power off
- plug the connector labeled 'PCT600' to the sensor
- plug the connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with PCT600

Nominal range / A	7.5	15	30	60	120	225	450	600
Max. TRMS value / A	8.25	16.5	33	66	132	247.5	495	900
Max. peak value / A	21	42	84	168	336	703.5	900	900
Range peak value for accuracy calculation / A	21	42	84	168	336	703.5	1407	2812.5

Accuracy

Use PCT600 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.2.8 Connection of the sensor PCT600 with PCTSIU4

For the use of PCT600 with other instruments with current input and supply via PCTSIU4. Connect PCT600 with PCT-DSUB to PCTSIU4. Secondary current output at PCTSIU4 via two 4mm connectors.

2.2.9 Connection of the sensor PCT600 with SSU4

It is not recommended for new projects, but the sensor supply unit SSU4 can be used with modification for PSU60/200/400/700 and PSU-K3/K5/K10 and SSU4-K-L31 and direct current inputs I* and I.

2.2.10 Connection of the sensor PCT600 with LMG95

Use PSU/PCT-K-L95, supply via LMG95, no additional error terms.

2.2.11 Connection of the sensor PCT600 with LMG450

Use PCT600-K-L45 and SSU4 (standard version).

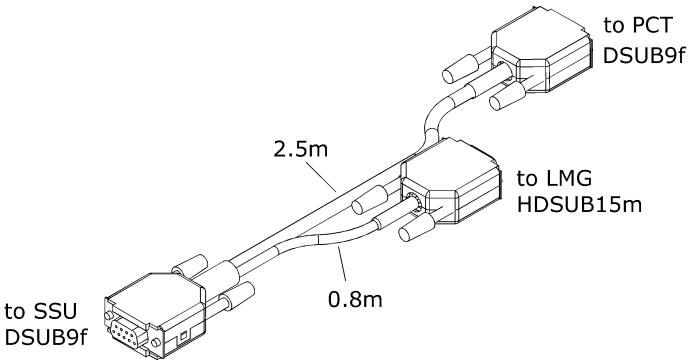

Figure 2.17: PCT600-K-L45

This cable 'PCT600-K-L45' is used to connect a precision current sensor PCT600 to the power meter LMG450 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG450 contains the adjustment data of the PCT600 head as well as the serial number. The rangenames of LMG450, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG450 with PCT600

Nominal range / A	18.7	37.5	75	150	300	600
Max. TRMS value / A	25	50	100	200	400	800
Max. peak value / A	28.125	56.25	112.5	225	450	900

Accuracy

Use PCT600 and LMG450 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±100 mA DC offset tolerance.

2.2.12 Connection of the sensor PCT600 with LMG500

Use PCT600-K-L50 and L50-Z14, supply via LMG500.

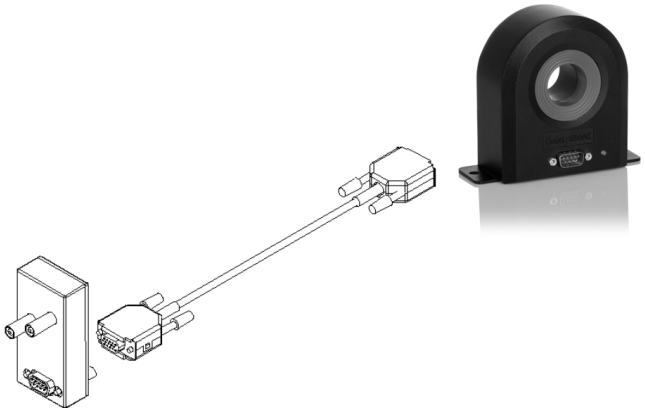

Figure 2.18: PCT600 and PCT600-K-L50 and L50-Z14

This cable 'PCT600-K-L50' is used to connect a precision current sensor PCT600 to the power meter LMG500 and to supply it by a sensor supply unit SSU4. Internal electronic of the connector to the LMG500 contains the adjustment data of the PCT600 head as well as the serial number. The rangenames of LMG500, the sensor name and calibration data are read out of the sensor EEPROM automatically.

Measuring ranges LMG500 with PCT600

Nominal range / A	4.5	9	18	37.5	75	150	300	600
Max. TRMS value / A	6.25	12.5	25	50	100	200	400	800
Max. peak value / A	7.031	14.063	28.125	56.25	112.5	225	450	900

Accuracy
Use PCT600 and LMG500 specifications to calculate the accuracy of the complete system.
Add ±0.01 % of measuring value.
Add ±100 mA DC offset tolerance.

2.2.13 Connection elongation

To use the current sensor with a larger connection length between power meter and PCT connect a well shielded extention cable between the PCT (DSUB9f plug) and the PCT connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES ZIMMER: 'LMG-Z-SVTxx' or 'LMG-Z-DV' in different lenths from 5m to 50m. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

2.3 Precision current transducer 2000 A (PCT2000)

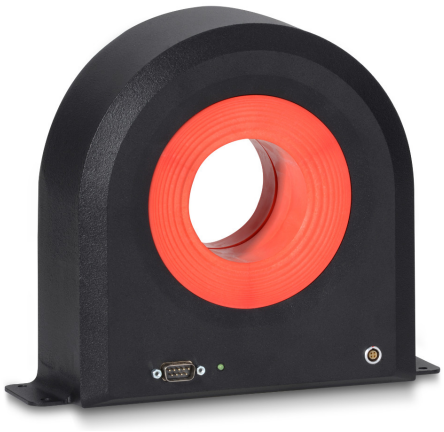

Figure 2.19: PCT2000

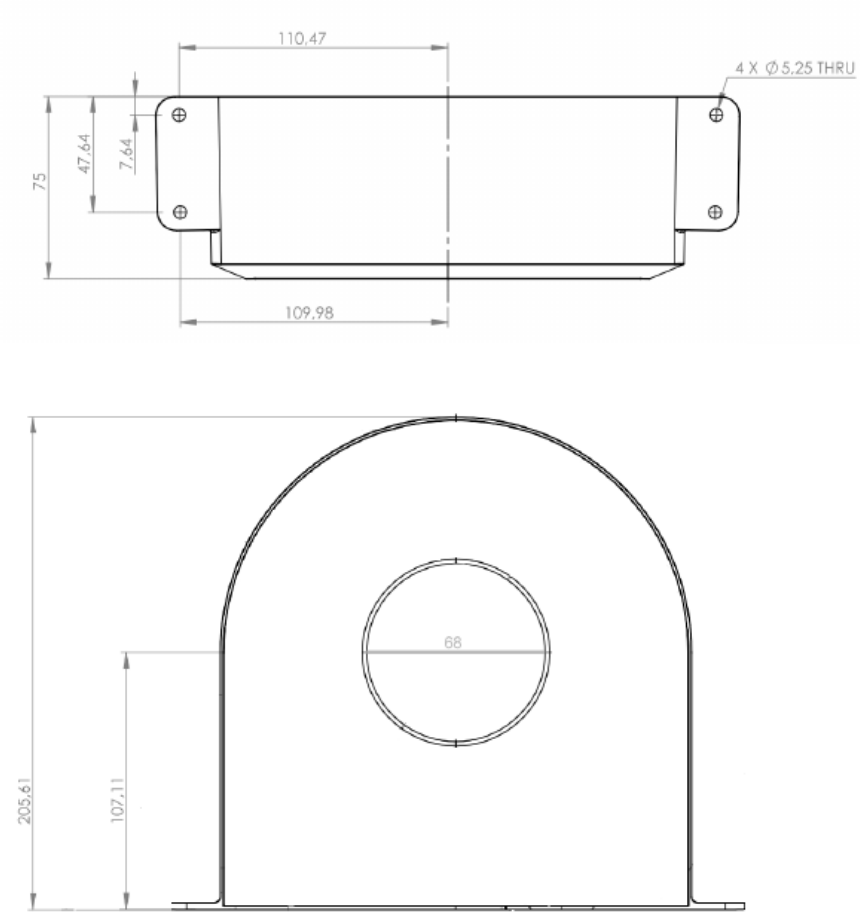

Figure 2.20: PCT2000 mechanical dimensions

2.3.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter Safety recommendations [1.2→5]!

2.3.2 Specifications

Nominal input current rms	2000 A
Maximum input current rms	3000 A
Maximum input current peak	3000 A
Transformation ratio	1500:1
Maximum input overload	10 kA (100 ms)
Bandwidth	10 kHz
Burden	0 ... 1 Ω
Safety standard	EN 61010-1
Rated isolation voltage rms, reinforced isolation	1600 V CAT II, pollution degree 2
Rms voltage for AC isolation test, 50/60 Hz, 1 min between primary and (secondary and shield) between secondary and shield	 9.8 kV 200 V
Impulse withstand voltage	20 kV
Creepage distance	22 mm
Comparative Tracking Index	CTI 600
Operating temperature	-40 °C ... +65 °C
Storage temperature	-40 °C ... +65 °C
Weight	4.5 kg
Supply	±(15 V±0.75 V) 2.1 A
EMC	EN 61326-1

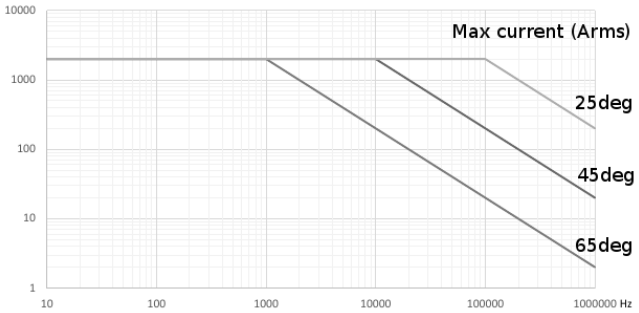

Figure 2.21: PCT2000 temperature derating of input current vs. frequency and temperature

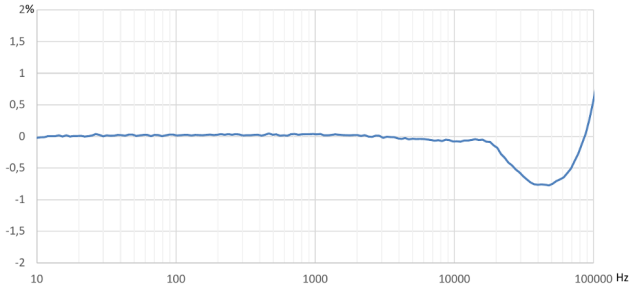

Figure 2.22: PCT2000 typical gain error vs. frequency

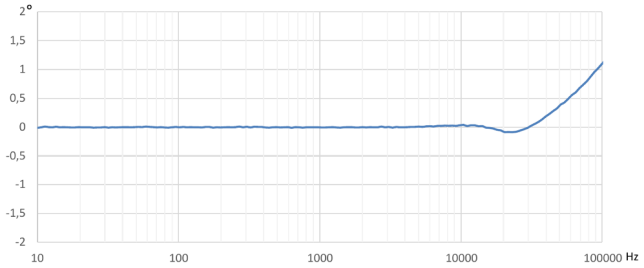

Figure 2.23: PCT2000 typical phase error vs. frequency

2.3.3 DSUB9 connector pin assignment of PCT2000

DSUB9 pin	
1	output current return
2	nc
3	status
4	GND
5	-supply
6	output current
7	nc
8	status
9	+supply

Status pin properties: Open collector output with forward direction pin 8 to pin 3. Maximum forward current: 10 mA. Maximum forward voltage: 60 V. Maximum reverse voltage: 5 V.

2.3.4 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT2000 is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT2000 using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT2000 is also recommended to lead away capacitive coupled distortion.

Also if bare conductors can be used up to the above values, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Do not power up the device before all cables are connected!

Connect a PCT-DSUB cable between supply unit and the sensor. Available cable lengths are: 2m, 5m and 10m.

Connect an instrument with low impedance current path on the secondary output (4mm red and black connectors).

When all connections are secured - connect mains power. When mains is applied a green light diode at the front next to symbol 'power' will light green. For each sensor connected a green light diode will light on the front if the connection is correct and the sensor is operating within normal range.

2.3.5 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the transducer.

Frequency	Amlitude uncertainty in % of nominal input current rms	Phase uncertainty
DC ... 500 Hz	±0.01 %	±0.04 °
500 Hz ... 1 kHz	±0.01 %	±0.4 °
1 kHz ... 10 kHz	±2.5 %	±2.5 °

Temperature coefficient ±0.1 ppm/°C of maximum input current peak in the temperature range of -40 °C ... +65 °C .

2.3.6 Sensor without supply or open secondary circuit

Both AC and DC primary current can be applied up to 100 % of nominal current under following conditions:

- Sensor is unpowered and secondary circuit is open
- Sensor is unpowered and secondary circuit is closed
- Sensor is powered and secondary circuit is open
- Sensor is powered and secondary circuit is interrupted during measurement

Note that the sensor core will be magnetized in all four cases, leading to a small change in output offset current.

2.4 Precision current transformer 1500 A (LMG-Z502, -Z505, -Z510, -Z520)

Figure 2.24: LMG-Z502, -Z505, -Z510, -Z520

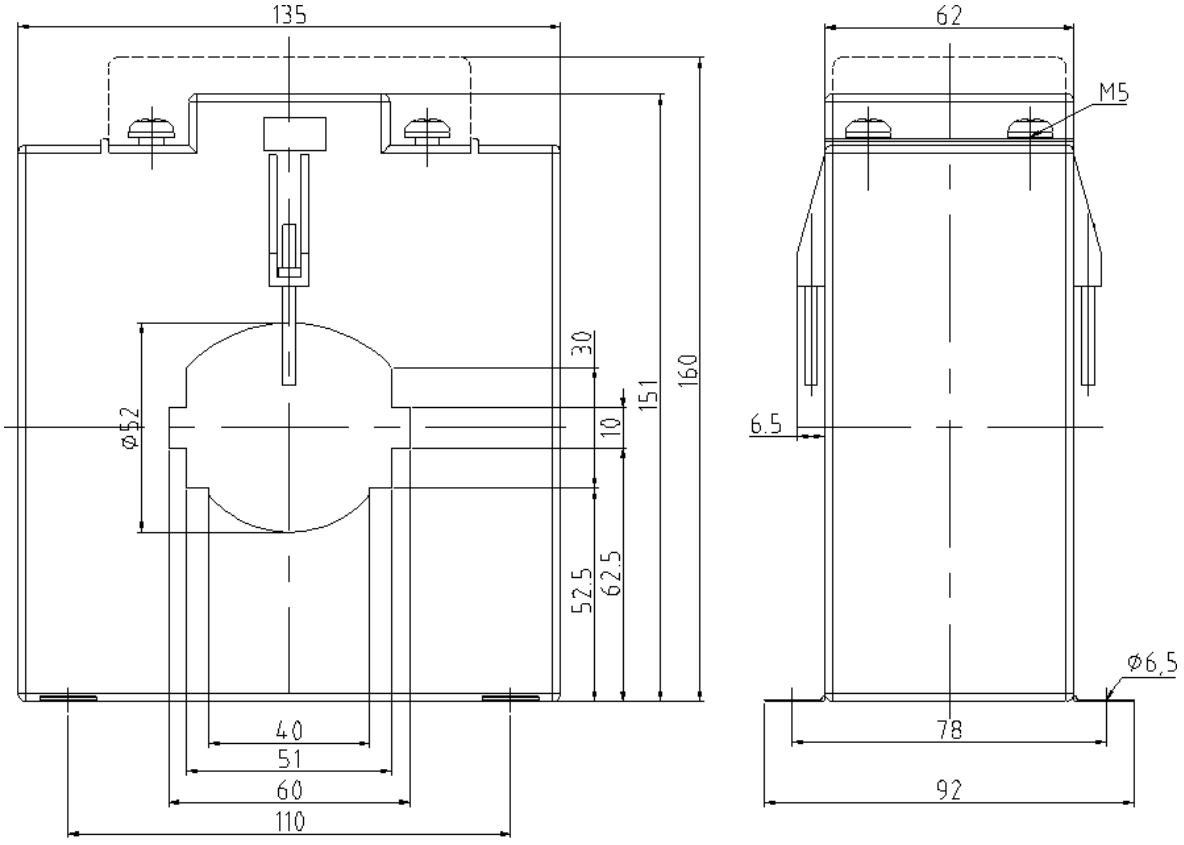

Figure 2.25: Dimensions in mm of LMG-Z502, -Z505, -Z510, -Z520

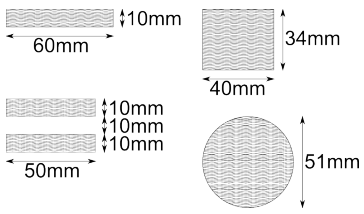

Figure 2.26: LMG-Z502, -Z505, -Z510, -Z520 suitable bus bars

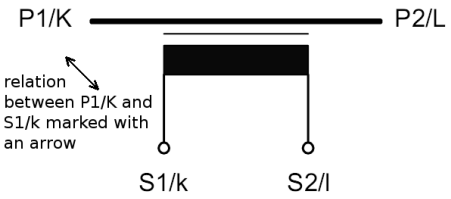

Figure 2.27: LMG-Z502, -Z505, -Z510, -Z520 connection diagram

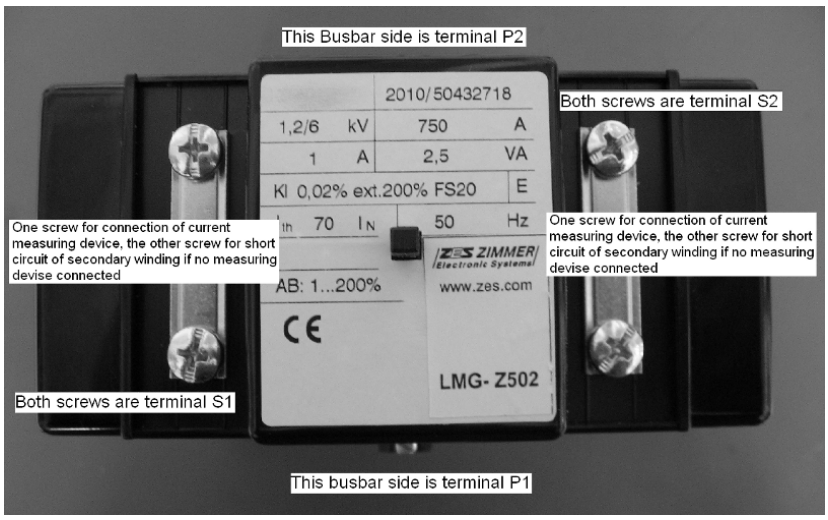

Figure 2.28: topview of LMG-Z502, -Z505, -Z510, -Z520

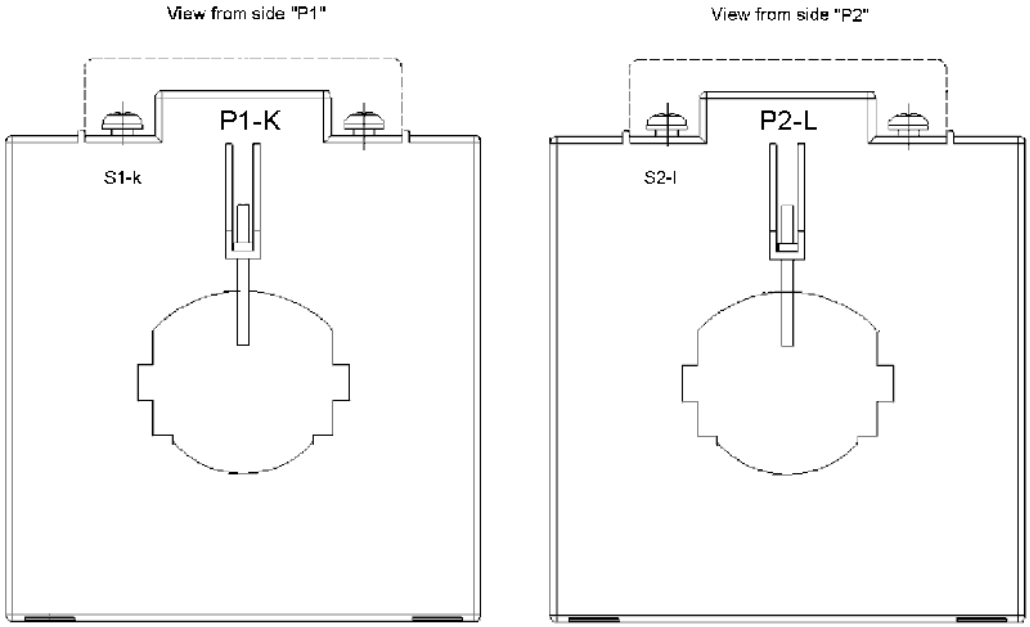

Figure 2.29: orientation of LMG-Z502, -Z505, -Z510, -Z520

2.4.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.4.2 Specifications

Measuring range	1500 Aeff continuous
Secondary current	2 Aeff
Rated Transformation ratio	750:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category Highest voltage for equipment (U_m) Test voltage	600 V CAT IV / 1000 V CAT III (EN 61010-1) 1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN}) Rated secondary Current (I_{SN}) Rated Continuous Thermal Current (I_d) Rated Short-Time Thermal Current (I_{th}) Instrument Security Factor (FS)	750 A 1 A 1500 A $70 * I_N$ (1 s) $\leq 20 * I_N$
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	2.5 kg
Bus bar	1x 60 mm x 10 mm or 2x 50 mm x 10 mm or 1x 40 mm x 34 mm or round, diameter 51mm primary fixing device M4x40, slotted headless screw, max. 2 Nm
Minimum center distance between adjacent bus bars	135 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm^2 (flexible) / 6 mm^2 (solid), tightening torque 3.5 Nm

2.4.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, primary conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥135 mm.

Amplitude error ±(% of measuring value) / Phase error (at 48 ... 66 Hz)				
Current	Z502	Z505	Z510	Z520
7.5 A ... 37.5 A	≤0.05 / ≤0.1°	≤0.1 / ≤0.1°	≤0.3 / ≤0.15°	≤0.5 / ≤0.3°
37.5 A ... 150 A	≤0.03 / ≤0.07°	≤0.07 / ≤0.07°	≤0.15 / ≤0.1°	≤0.3 / ≤0.2°
150 A ... 375 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°
375 A ... 900 A	≤0.02 / ≤0.04°	≤0.05 / ≤0.04°	≤0.1 / ≤0.06°	≤0.2 / ≤0.12°
900 A ... 1500 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°	≤0.2 / ≤0.16°

At 30 Hz ... 48 Hz and 66 Hz ... 440 Hz twofold the errors, at 15 Hz ... 30 Hz and 440 Hz ... 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z502, -Z505, -Z510, -Z520 and LMG specifications to calculate the accuracy of the complete system.

2.4.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to HINTS FOR WIRING CURRENT TRANSFORMERS OR HST TO LMG [4.5→96].

2.5 Precision current transformer 4000 A (LMG-Z542, -Z545, -Z550)

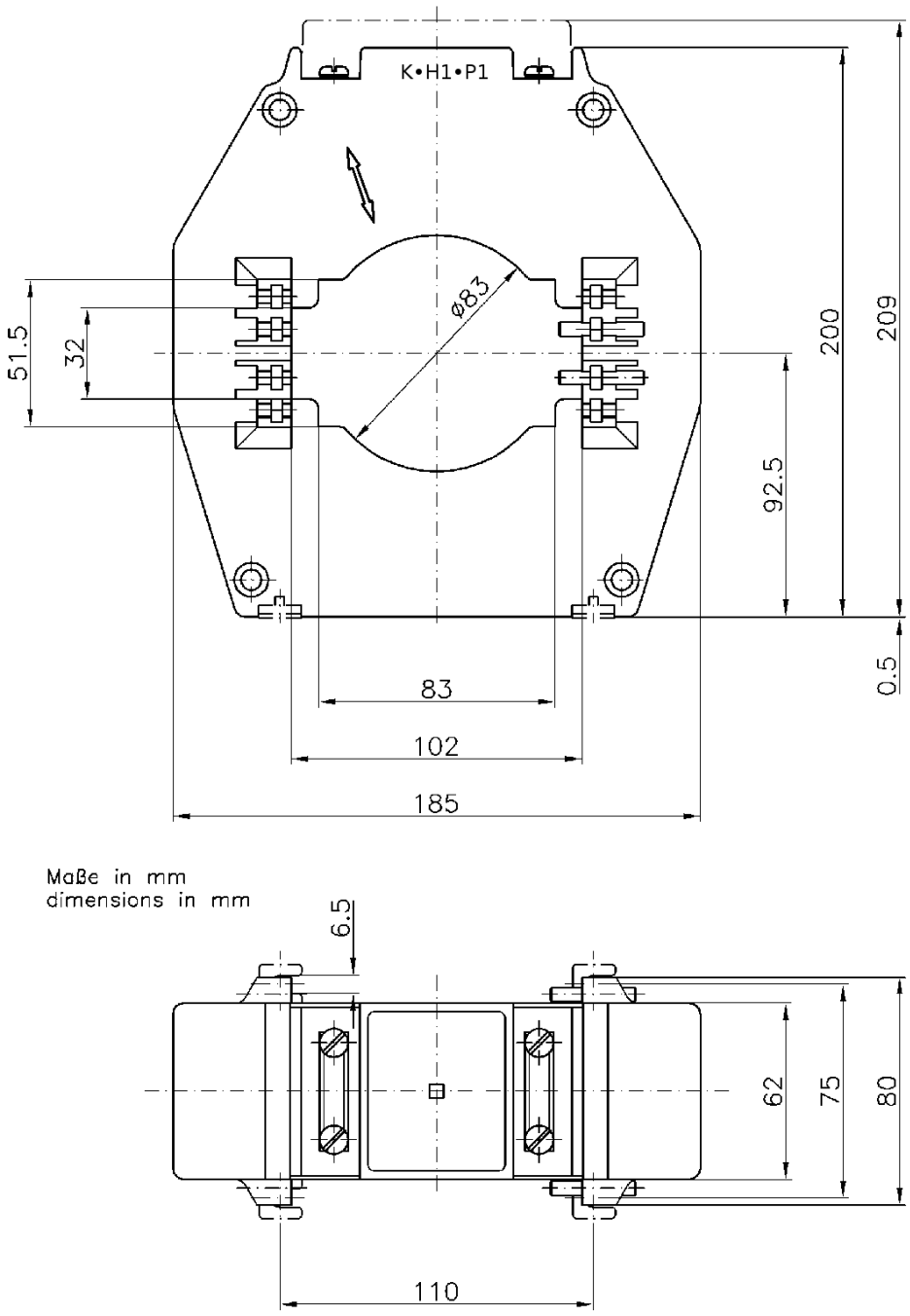

Figure 2.30: Dimensions in mm of LMG-Z542, -Z545, -Z550

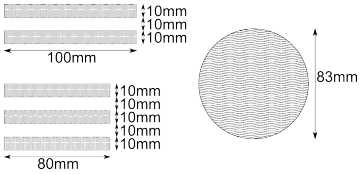

Figure 2.31: LMG-Z542, -Z545, -Z550 suitable bus bars

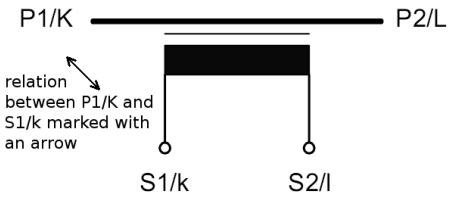

Figure 2.32: LMG-Z542, -Z545, -Z550 connection diagram

2.5.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.5.2 Specifications

Measuring range	4000 Aeff continuous
Secondary current	2 Aeff
Rated Transformation ratio	2000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category Highest voltage for equipment (U_m) Test voltage	600 V CAT IV / 1000 V CAT III (EN 61010-1) 1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN}) Rated secondary Current (I_{SN}) Rated Continuous Thermal Current (I_d) Rated Short-Time Thermal Current (I_{th}) Instrument Security Factor (FS)	2000 A 1 A 4000 A $100 * I_N$ (1 s) $\leq 40 * I_N$
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	3.3 kg
Bus bar	2x 100 mm x 10 mm or 3x 80 mm x 10 mm or round, diameter 83mm
Minimum center distance between adjacent bus bars	185 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm^2 (flexible) / 6 mm^2 (solid), tightening torque 3.5 Nm

2.5.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, primary conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥185 mm.

Amplitude error ±(% of measuring value) / Phase error (at 48 … 66 Hz)			
Current	Z542	Z545	Z550
20 A … 100 A	≤0.1 / ≤0.1°	≤0.15 / ≤0.1°	≤0.3 / ≤0.15°
100 A … 400 A	≤0.04 / ≤0.07°	≤0.08 / ≤0.07°	≤0.15 / ≤0.1°
400 A … 1000 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°
1000 A … 2400 A	≤0.02 / ≤0.04°	≤0.05 / ≤0.04°	≤0.1 / ≤0.06°
2400 A … 4000 A	≤0.02 / ≤0.05°	≤0.05 / ≤0.05°	≤0.1 / ≤0.08°

At 30 Hz … 48 Hz and 66 Hz … 440 Hz twofold the errors, at 15 Hz … 30 Hz and 440 Hz … 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z542, -Z545, -Z550 and LMG specifications to calculate the accuracy of the complete system.

2.5.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to Hints for wiring current transformers or HST to LMG [4.5→96].

2.6 Precision current transformer 10 kA (LMG-Z562, -Z570)

Figure 2.33: LMG-Z562, -Z570

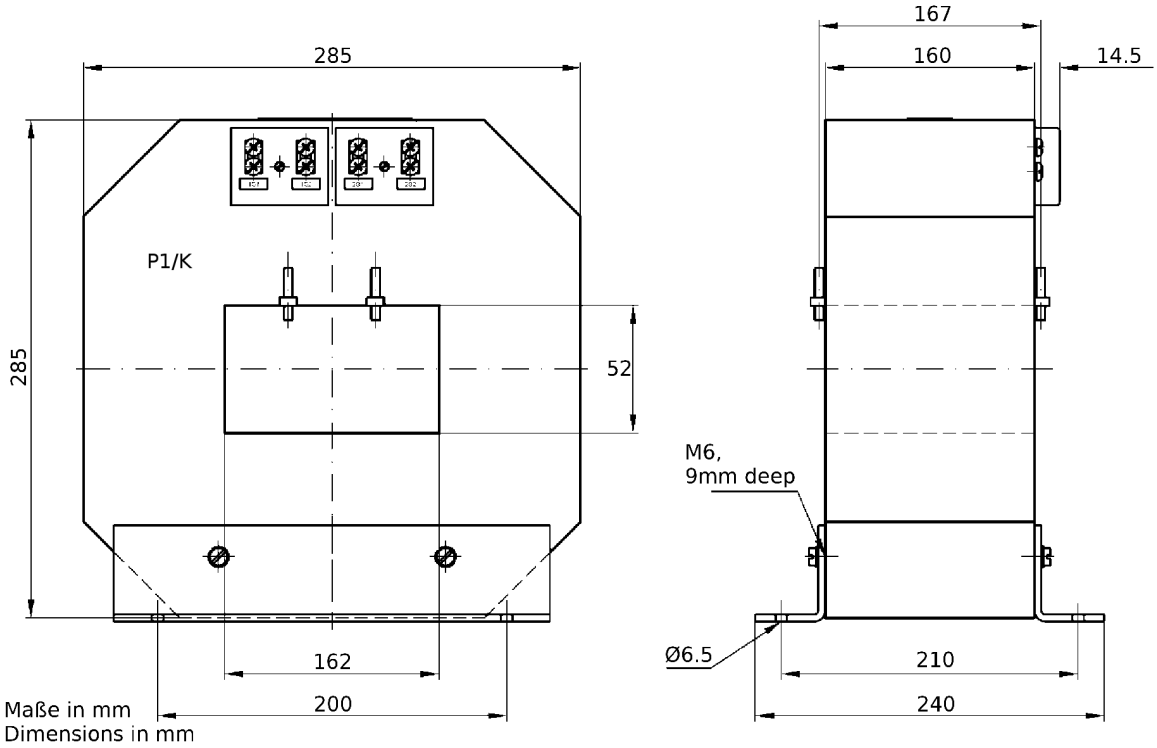

Figure 2.34: Dimensions in mm of LMG-Z562, -Z570

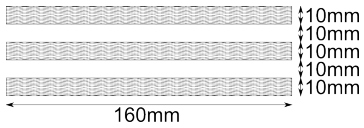

Figure 2.35: LMG-Z562, -Z570 suitable bus bars

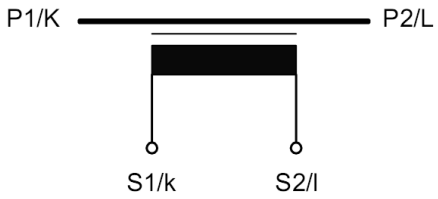

Figure 2.36: LMG-Z562, -Z570 connection diagram

2.6.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.6.2 Specifications

Measuring range	10 kAeff continuous
Secondary current	2 Aeff
Rated Transformation ratio	5000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category Highest voltage for equipment (U_m) Test voltage	600 V CAT IV / 1000 V CAT III (EN 61010-1) 1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN}) Rated secondary Current (I_{SN}) Rated Continuous Thermal Current (I_d) Rated Short-Time Thermal Current (I_{th}) Instrument Security Factor (FS)	5000 A 1 A 10 kA $100 * I_N$ (1 s) $\leq 55 * I_N$
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	32 kg
Bus bar	3x 160 mm x 10 mm primary fixing device M5, slotted headless screw, max. 2.5 Nm
Minimum center distance between adjacent bus bars	285 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm^2 (flexible) / 6 mm^2 (solid), tightening torque 3.5 Nm

2.6.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, primary conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥285 mm.

Amplitude error ±(% of measuring value) / Phase error (at 48 … 66 Hz)		
Current	Z562	Z570
50 A … 250 A	≤0.05 / ≤0.1°	≤0.3 / ≤0.15°
250 A … 1000 A	≤0.03 / ≤0.07°	≤0.15 / ≤0.1°
1000 A … 2500 A	≤0.02 / ≤0.05°	≤0.1 / ≤0.08°
2500 A … 6000 A	≤0.02 / ≤0.04°	≤0.1 / ≤0.06°
6000 A … 10 kA	≤0.02 / ≤0.05°	≤0.1 / ≤0.08°

At 30 Hz … 48 Hz and 66 Hz … 440 Hz twofold the errors, at 15 Hz … 30 Hz and 440 Hz … 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z562, -Z570 and LMG specifications to calculate the accuracy of the complete system.

2.6.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to Hints for wiring current transformers or HST to LMG [4.5→96].

2.7 Precision current transformer 10 kA (LMG-Z582, -Z590)

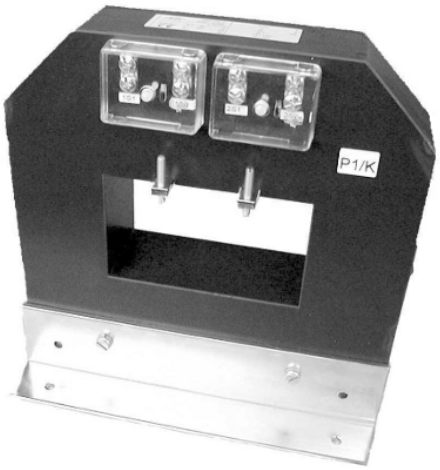

Figure 2.37: LMG-Z582, -Z590 (picture similar)

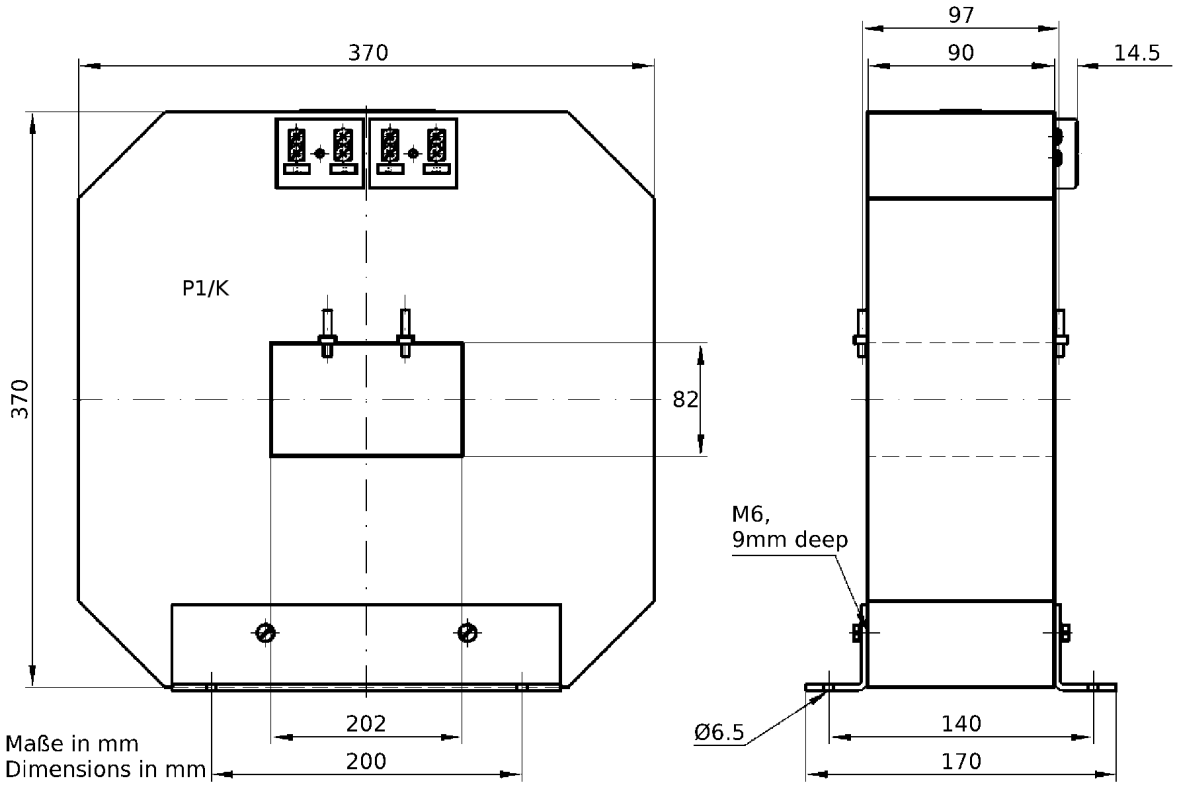

Figure 2.38: Dimensions in mm of LMG-Z582, -Z590

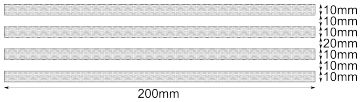

Figure 2.39: LMG-Z582, -Z590 suitable bus bars

Figure 2.40: LMG-Z582, -Z590 connection diagram

2.7.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.7.2 Specifications

Measuring range	10 kAeff continuous
Secondary current	2 Aeff
Rated Transformation ratio	5000:1
Bandwidth	15 Hz ... 5 kHz
Burden impedance	1 ... 2.5 Ω, cos(beta) = 1
Measurement category Highest voltage for equipment (U_m) Test voltage	600 V CAT IV / 1000 V CAT III (EN 61010-1) 1.2 kV (EN 60664-1) 6 kV, 50 Hz, 1 min
Rated primary Current (I_{PN}) Rated secondary Current (I_{SN}) Rated Continuous Thermal Current (I_d) Rated Short-Time Thermal Current (I_{th}) Instrument Security Factor (FS)	5000 A 1 A 10 kA $80 * I_N$ (1 s) $\leq 80 * I_N$
Degree of pollution	2
Operating temperature	-5 °C ... +40 °C
Weight	23 kg
Bus bar	4x 200 mm x 10 mm primary fixing device M5, slotted headless screw, max. 2.5 Nm
Minimum center distance between adjacent bus bars	370 mm
Output connection	screw terminals M5, Philips recessed head screw, max. 4 mm^2 (flexible) / 6 mm^2 (solid), tightening torque 3.5 Nm

2.7.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature -5 °C ... +40 °C, primary conductor in the middle of the transformer, total burden impedance (including wiring and current path of LMG) between 1 and 2.5 Ω, center distance between adjacent bus bars ≥370 mm.

Amplitude error ±(% of measuring value) / Phase error (at 48 … 66 Hz)		
Current	Z582	Z590
50 A … 250 A	≤0.05 / ≤0.1°	≤0.3 / ≤0.15°
250 A … 1000 A	≤0.03 / ≤0.07°	≤0.15 / ≤0.1°
1000 A … 2500 A	≤0.02 / ≤0.05°	≤0.1 / ≤0.08°
2500 A … 6000 A	≤0.02 / ≤0.04°	≤0.1 / ≤0.06°
6000 A … 10 kA	≤0.02 / ≤0.05°	≤0.1 / ≤0.08°

At 30 Hz … 48 Hz and 66 Hz … 440 Hz twofold the errors, at 15 Hz … 30 Hz and 440 Hz … 5 kHz threefold the errors. Calibration interval of 1 year is recommended. Use LMG-Z582, -Z590 and LMG specifications to calculate the accuracy of the complete system.

2.7.4 Connection of the precision current transformers with LMG

Use LMG inputs I* and I, please refer to Hints for wiring current transformers or HST to LMG [4.5→96].

2.8 Active error compensated AC current clamp 40 A (L60-Z406)

Figure 2.41: L60-Z406

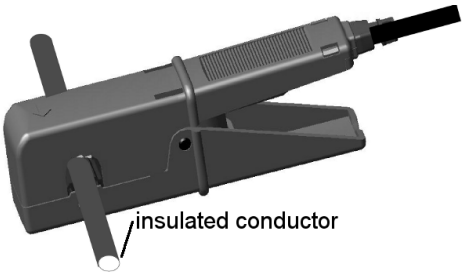

Figure 2.42: L60-Z406

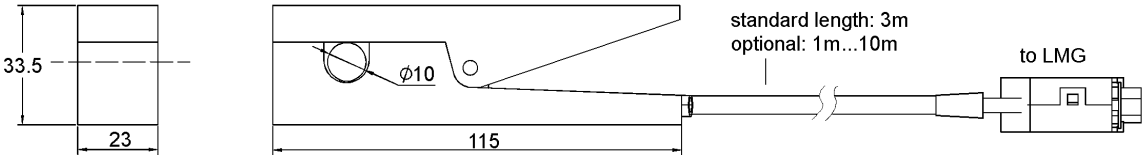

Figure 2.43: Dimensions of L60-Z406

2.8.1 Safety warnings

- No safety isolation, measurements only at insulated conductors allowed!
- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.8.2 Specifications

Nominal input current	40 A
Measuring range	66 A / 120 Apk
Maximum input overload	500 A for 1 s
Bandwidth	5 Hz ... 50 kHz
Isolation	bare conductor: phase / ground 30 Veff insulated conductor: see cable spec.
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	120 g
Output connection	3 m fixed lead with DSUB15 plug to LMG optional: 1 m ... 10 m

With its high basic accuracy, the lower cut-off frequency of 5 Hz and the upper cut-off frequency of 50 kHz this clamp fits best for measurements at frequency inverter output. The internal error compensation circuit is designed especial for this application.

2.8.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp. The values are in ±(% of measuring value + % of measuring range peak) and in ±(phase error in degree)

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

Frequency	5 Hz to 10 Hz	10 Hz to 45 Hz	45 Hz to 1 kHz	1 kHz to 5 kHz	5 kHz to 20 kHz	20 kHz to 50 kHz
Current	1.5 %+0.25 %	0.4 %+0.15 %	0.15 %+0.05 %	0.3 %+0.15 %	1 %+0.25 %	4 %+0.5 %
Phase	6 °	3 °	0.5 °	2 °	6 °	20 °

2.8.4 Connection of the current clamp L60-Z406 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z406 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z406

Nominal range / A	0.45	0.9	1.8	3.75	7.5	15	30	40
Max. TRMS value / A	0.495	0.99	1.98	4.125	8.25	16.5	33	66
Max. peak value / A	1.4655	2.9295	5.859	11.7195	23.445	46.875	93.75	120
Range peak value for accuracy calculation / A	1.4655	2.9295	5.859	11.7195	23.445	46.875	93.75	187.5

Accuracy

Use L60-Z406 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.9 Error compensated AC current clamp 1000 A (L60-Z60)

Figure 2.44: L60-Z60

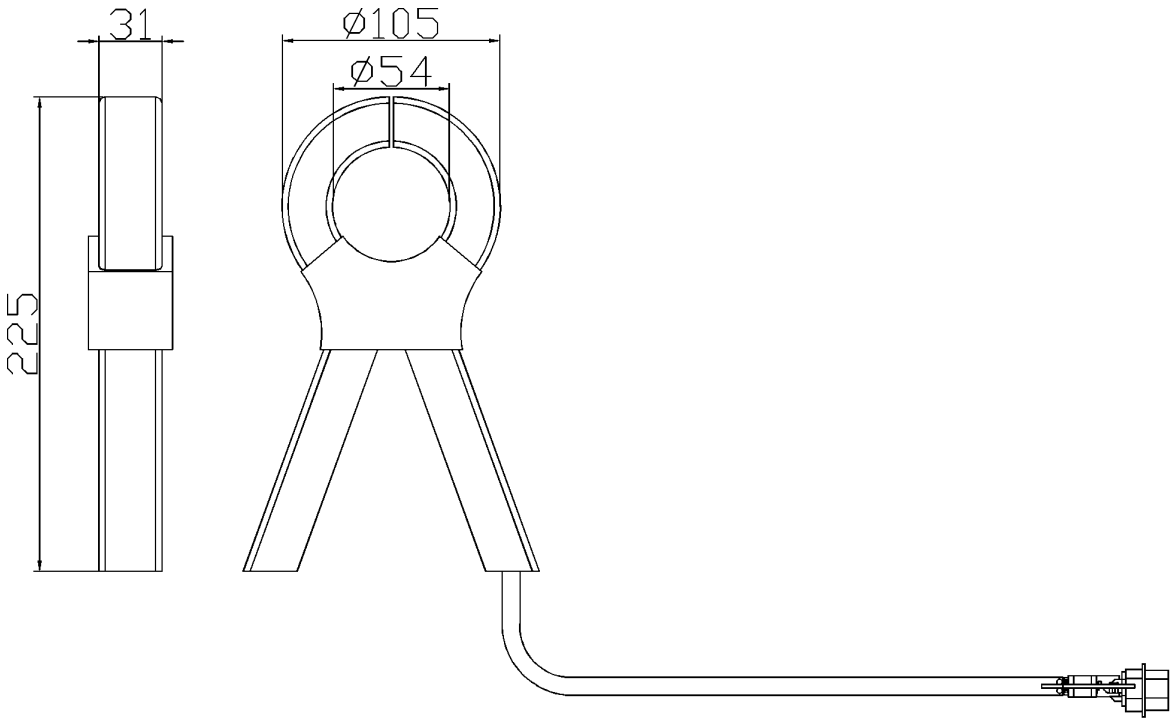

Figure 2.45: Dimensions of L60-Z60

2.9.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

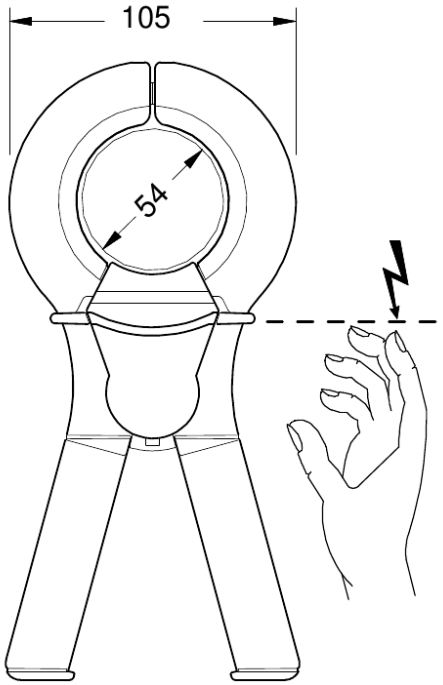

Figure 2.46: Protection against electric shock

2.9.2 Specifications

Nominal input current	1000 A
Measuring range	1200 A / 3000 Apk
Maximum input overload	1200 A continuous, 2000 A for 5 min./h @ +20 °C
Bandwidth	30 Hz ... 10 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	650 g
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.9.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz, linear interpolation is allowed.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A	±1.5 %	±2 °
10 A	±1.5 %	±2 °
200 A	±0.75 %	±0.75 °
1000 A	±0.5 %	±0.5 °

Use L60-Z60 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.9.4 Connection of the current clamp L60-Z60 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z60 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z60

Nominal range / A	5	10	20	40	80	150	300	600	1000
Max. TRMS value / A	5.5	11	22	44	88	165	330	660	1200
Max. peak value / A	14	28	56	112	224	469	938	1875	3000
Range peak value for accuracy calculation / A	14	28	56	112	224	469	938	1875	3750

Accuracy

Use L60-Z60 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.10 Error compensated AC current clamp 3000 A (L60-Z66)

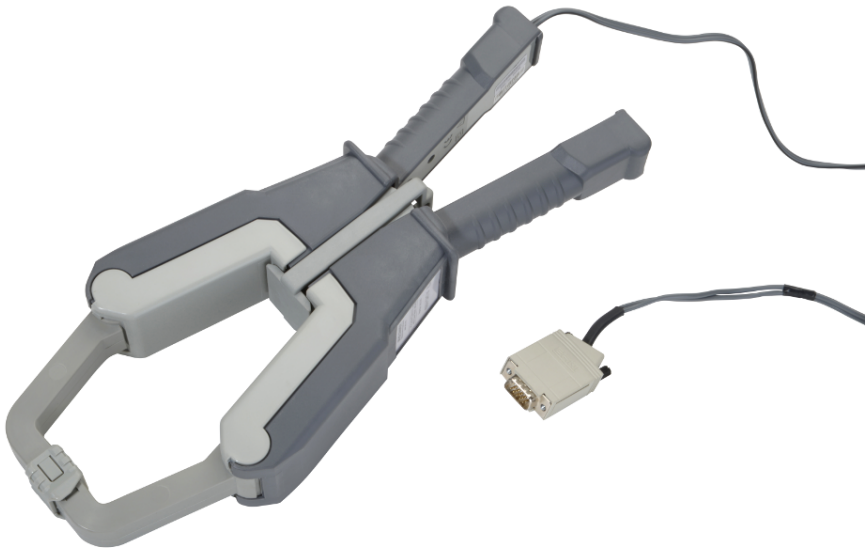

Figure 2.47: L60-Z66

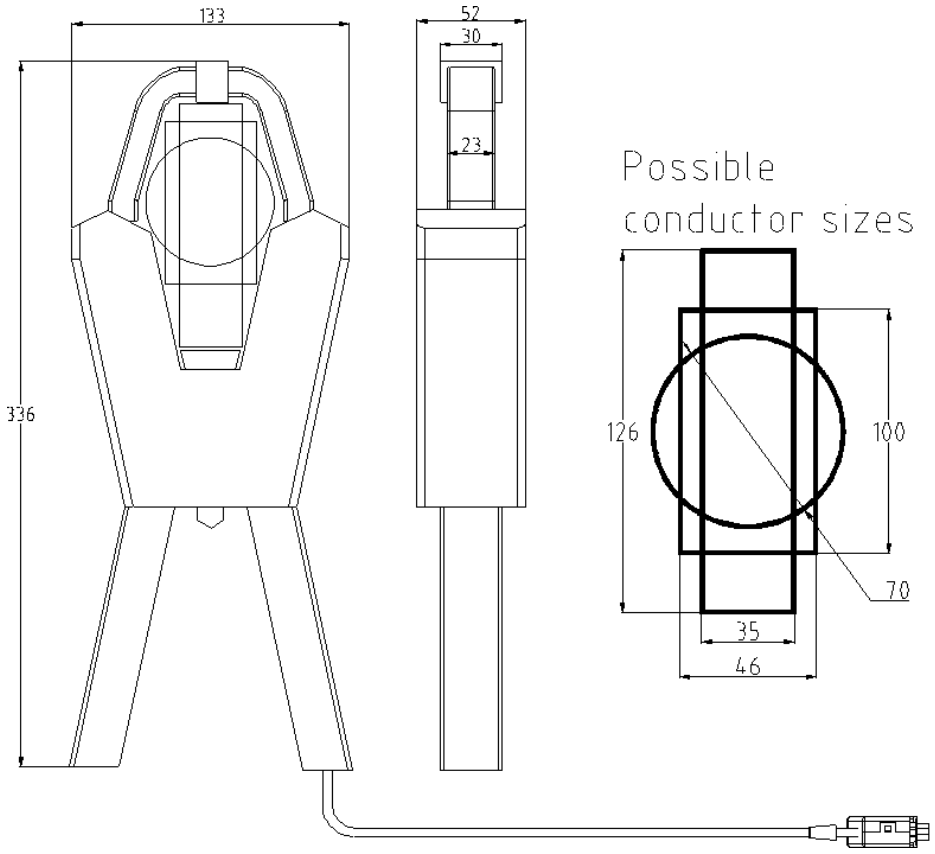

Figure 2.48: Dimensions of L60-Z66

2.10.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use safety cover 'P' Figure 2.49 [→47] for protection against short-circuits during clamping!
- Please refer to chapter Safety recommendations [1.2→5]!

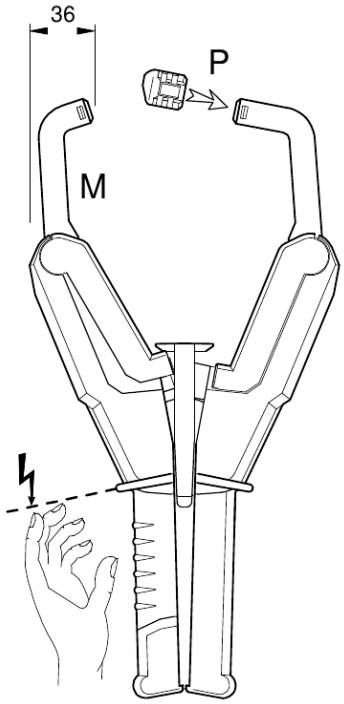

Figure 2.49: Protection against electric shock and short-circuit

2.10.2 Specifications

Nominal input current	3000 A
Measuring range	3200 A / 9000 Apk
Maximum input overload	3600 A continuous, 6000 A for 5 min/h @ +20 °C
Bandwidth	40 Hz ... 5 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	1.88 kg
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.10.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A ... 100 A	±2 %	±1.6 °
100 A ... 1000 A	±1 %	±1 °
1000 A ... 3000 A	±0.5 %	±0.5 °

Use L60-Z66 and LMG specifications to calculate the accuracy of the complete system.

Influence of coupling mode: This current clamp can measure only AC currents. DC offset could cause additional errors. Therefore this clamp should only be used with the LMG setting: AC coupling. The accuracies are only valid for this case.

2.10.4 Connection of the current clamp L60-Z66 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z66 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z66

Nominal range / A	15	30	60	120	240	450	900	1800	3000
Max. TRMS value / A	16.5	33	66	132	264	495	990	1980	3200
Max. peak value / A	42	84	168	336	672	1407	2814	5625	9000
Range peak value for accuracy calculation / A	42	84	168	336	672	1407	2814	5625	11250

Accuracy

Use L60-Z66 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.11 AC/DC current clamp 1000 A (L60-Z68)

Figure 2.50: L60-Z68

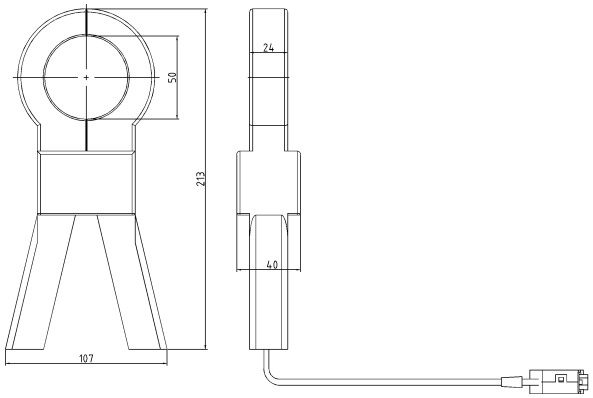

Figure 2.51: Dimensions of L60-Z68

2.11.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Please refer to chapter Safety recommendations [1.2→5]!

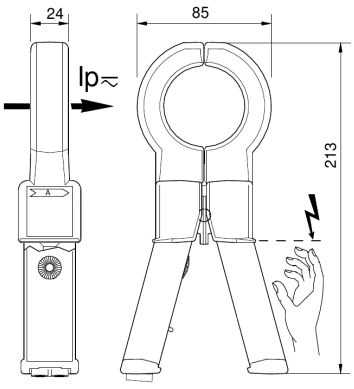

Figure 2.52: Protection against electric shock and short-circuit

2.11.2 Specifications

Nominal input current	1000 A
Max. trms value	1100 A
Measuring range	1500 Apk
Maximum input overload	1500 A continuous @ +20 °C
Bandwidth	DC ... 2 kHz
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	0.6 kg
Output connection	2 m fixed lead with DSUB15 plug to LMG

2.11.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp. Zero offset adjusted to zero.

Current	Amplitude error DC	Phase error at 1 kHz
100 A ... 1100 A	±2 %	±4 °

Use L60-Z68 and LMG specifications to calculate the accuracy of the complete system.

2.11.4 Connection of the current clamp L60-Z68 with LMG600

Use current sensor adapter L60-X-ADSE.

Internal electronic of the connector to the LMG600 contains the adjustment data of the current clamp L60-Z68 as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Measuring ranges LMG600 with L60-Z68

Nominal range / A	30	60	120	250	500	1000
Max. TRMS value / A	33	66	132	275	550	1100
Max. peak value / A	97.7	195.3	390.6	781.3	1500	1500
Range peak value for accuracy calculation / A	97.7	195.3	390.6	781.3	1563	3125

Accuracy

Use L60-Z68 and LMG600 specifications to calculate the accuracy of the complete system.

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

2.12 AC current clamp 1000 A/1 A (LMG-Z322)

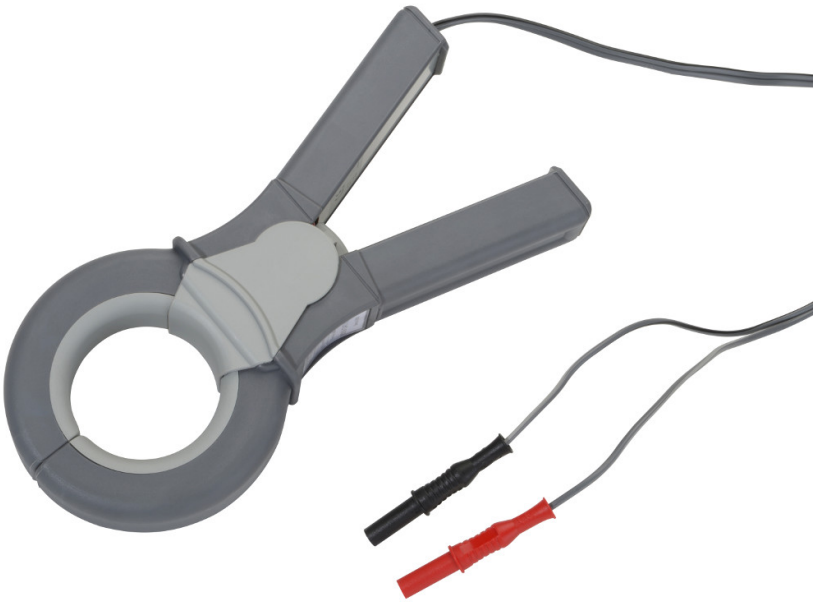

Figure 2.53: LMG-Z322

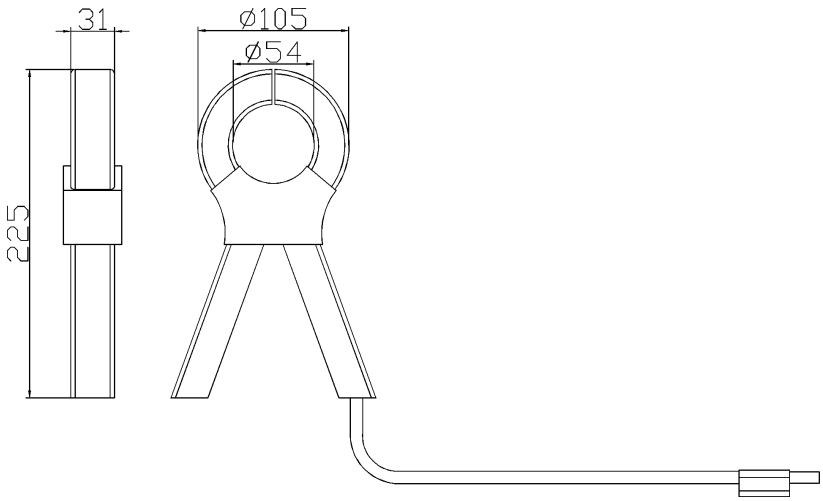

Figure 2.54: Dimensions of LMG-Z322

2.12.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Please refer to chapter Safety recommendations [1.2→5]!

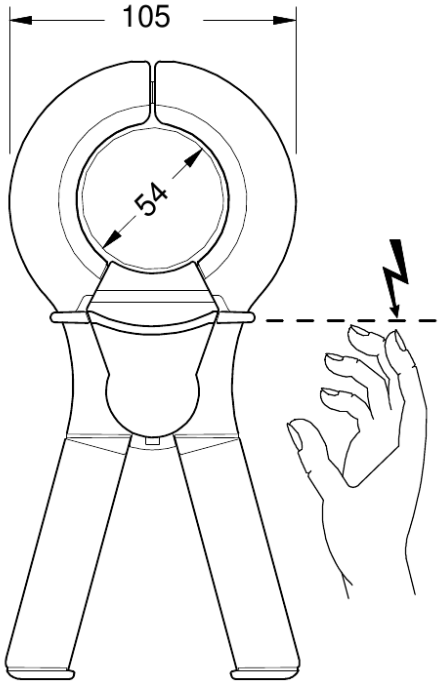

Figure 2.55: Protection against electric shock

2.12.2 Specifications

Nominal input current	1000 A
Transformation ratio	1000 : 1
Measuring range	1200 A
Maximum input overload	1200 A continuous, 2000 A for 5 min./h @ +20 °C
Bandwidth	30 Hz ... 10 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	650 g
Output connection	2 m fixed lead with 4 mm safety plugs

2.12.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz, linear interpolation is allowed.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A	±1.5 %	±2 °
10 A	±1.5 %	±2 °
200 A	±0.75 %	±0.75 °
1000 A	±0.5 %	±0.5 °

Use LMG-Z322 and LMG specifications to calculate the accuracy of the complete system.

2.13 AC current clamp 3000 A/1 A (LMG-Z329)

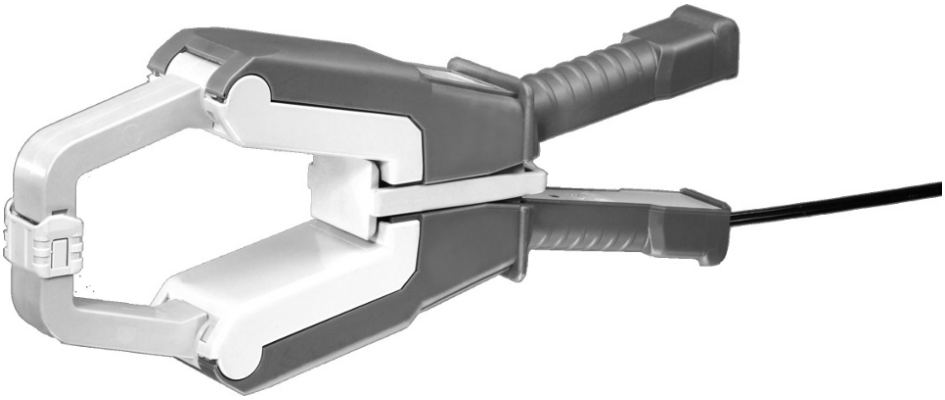

Figure 2.56: LMG-Z329

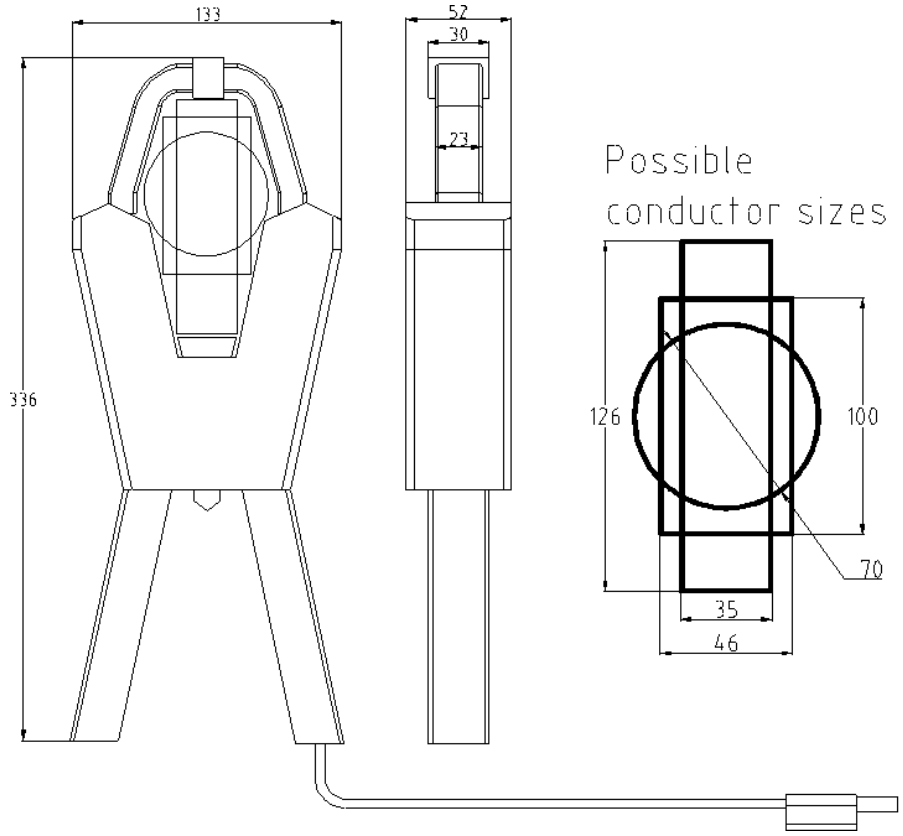

Figure 2.57: Dimensions of LMG-Z329

2.13.1 Safety warnings

- Always connect the sensor first to the meter, and afterwards to the device under test.
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Connecting cable without safety insulation! Aviod contact to hazardous voltage!
- Use safety cover 'P' Figure 2.58 [→54] for protection against short-circuits during clamping!
- Please refer to chapter Safety recommendations [1.2→5]!

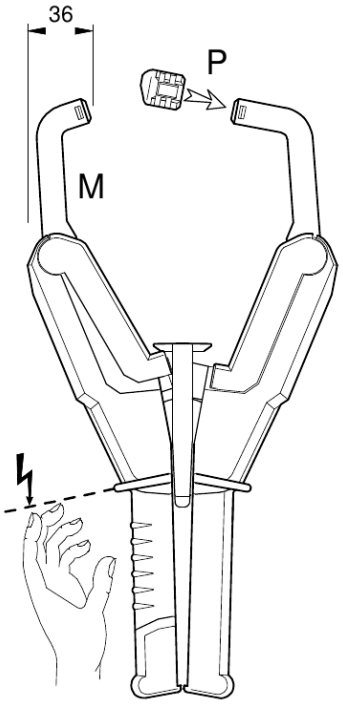

Figure 2.58: Protection against electric shock and short-circuit

2.13.2 Specifications

Nominal input current	3000 A
Transformation ratio	3000 : 1
Measuring range	3200 A
Maximum input overload	3600 A continuous, 6000 A for 5 min/h @ +20 °C
Bandwidth	40 Hz ... 5 kHz
Burden	<2.5 VA
Measurement category	600 V CAT III
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Weight	1.88 kg
Output connection	2 m fixed lead with 4 mm safety plugs

2.13.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, primary conductor in the middle of the clamp, signal frequency 50 Hz ... 60 Hz.

Current	Amlitude uncertainty in % of measuring value	Phase uncertainty in °
1 A ... 100 A	±2 %	±1.6 °
100 A ... 1000 A	±1 %	±1 °
1000 A ... 3000 A	±0.5 %	±0.5 °

Use LMG-Z329 and LMG specifications to calculate the accuracy of the complete system.

2.14 Precision wideband current transformer 100 A (WCT100)

Figure 2.59: WCT100

WCT100 is an accessory for the precision power meters LMG with a high bandwidth. The high frequency design provides best accuracy at high frequencies. It also simplifies the measurement of output power in high frequency applications with floating potential. The current transformer has 1 A current output, for the direct connection to the LMG current input. For the connection of WCT100 to the precision power meter LMG use narrow twisted laboratory leads, not longer than needed.

2.14.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter Safety recommendations [1.2→5]!

2.14.2 Specifications

Nominal input current rms	100 A
Maximum input current peak	250 Apk
Transformation ratio	100:1
Maximum input overload	120 A continuous, 200 A for 1 minute
Bandwidth	30 Hz ... 1 MHz
Output burden	0 ... 100 mΩ for specified accuracy
Isolation	600 V CAT III / 1000 V CATII (EN 61010-1), Test voltage: output Ilow to 20mm busbar
Output connection	safety sockets, 4 mm
Operating temperature	-10 °C ... +70 °C
Through hole diameter	23 mm
Weight	350 g
Size l * w * h	120 mm * 95 mm * 65 mm

2.14.3 Uncertainty

The uncertainties are based on: no DC current component, sinusoidal current, ambient temperature +23±3 ℃, calibration interval of 1 year, output burden max. 100 mΩ , max. 1 m twisted laboratory leads, primary conductor in the middle of the transducer.

Full power accuracy, for measuring current up to 100 A. Accuracy and bandwidth specification is for small signal as well as for wide signal level.

	30 Hz ... 100 Hz	100 Hz ... 100 kHz	100 kHz ... 300 kHz	300 kHz ... 1 MHz
Current ±(% of measuring value)	0.25 %	0.25 %	1 %	2 %
Phase ±(phase error in degree)	0.6 °	0.3 °	0.4 °	0.6 °

Use WCT100 and LMG specifications to calculate the accuracy of the complete system.

2.14.4 Improving the accuracy due to common mode effects

In high frequency applications with current measurement on high common mode voltage potential it might be advantageous to connect the yellow plug with earth. There is a double galvanic separation: inside the LMG and inside the current transformer itself and a capacitive coupling from the isolated primary lead to the current transformer. So the secondary side has neither galvanic contact with the load current nor with earth, the current channel is floating on an undefined potential. Parasitic currents by capacitive coupling from the primary conductor to secondary transformer side that is totally floating may influence measuring accuracy. These currents can be by-passed to earth over the yellow plug that is connected inside to the secondary side transformer coils in that way that the fields of these currents are compensated as not to create further disturbance and interference. The HF-accuracy can be improved by draging down the floating voltage to about earth potential, but this might also cause resonance, so beware not to distort the measurement accuracy.

2.15 Precision wideband current transformer 1000 A (WCT1000)

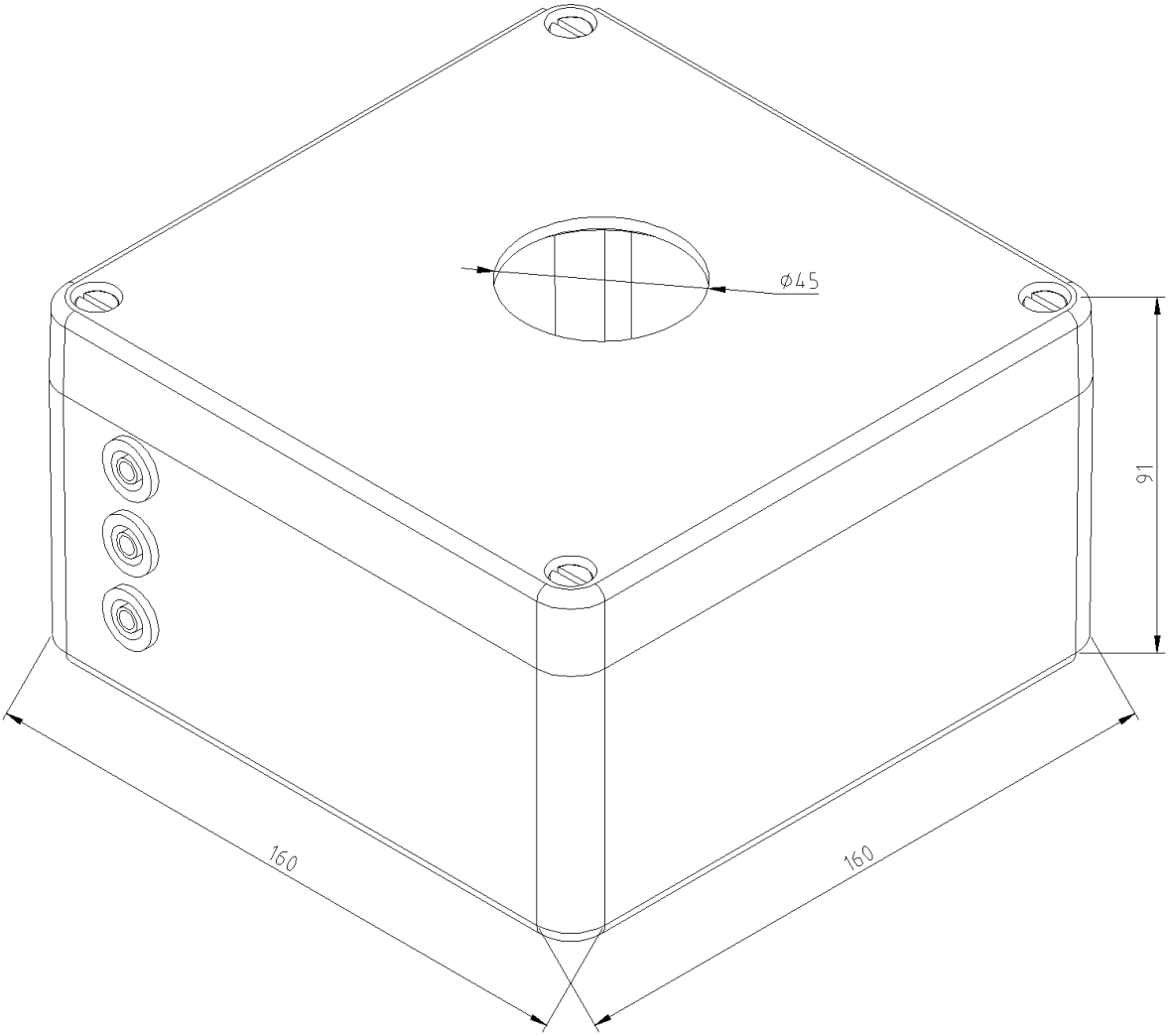

Figure 2.60: WCT1000

WCT1000 is an accessory for the precision power meters LMG with a high bandwidth. The high frequency design provides best accuracy at high frequencies. It also simplifies the measurement of output power in high frequency applications with floating potential. The current transformer has 1 A current output, for the direct connection to the LMG current input. For the connection of WCT1000 to the precision power meter LMG use narrow twisted laboratory leads, not longer than needed.

2.15.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- If no burden is connected, secondary terminals have to be short-circuited!
- Please refer to chapter Safety recommendations [1.2→5]!

2.15.2 Specifications

Nominal input current rms	1000 A
Maximum input current peak	2500 Apk
Transformation ratio	1000:1
Maximum input overload	1200 A continuous, 2000 A for 1 minute
Bandwidth	30 Hz ... 1 MHz
Output burden	0 ... 100 mΩ for specified accuracy
Isolation	bare primary conductor: 30 Veff, insulated primary conductor: see cable spec.
Output connection	safety sockets, 4 mm
Operating temperature	0 °C ... +50 °C
Through hole diameter	44 mm
Weight	3.3 kg
Size l * w * h	160 mm * 160 mm * 91 mm

2.15.3 Uncertainty

The uncertainties are based on: no DC current component, sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year, output burden max. 100 mΩ , max. 1 m twisted laboratory leads, primary conductor in the middle of the transducer.

Full power accuracy, for measuring current up to 1000 A. Accuracy and bandwidth specification is for small signal as well as for wide signal level.

	30 Hz ... 100 Hz	100 Hz ... 100 kHz	100 kHz ... 500 kHz	500 kHz ... 1 MHz
Current ±(% of measuring value)	0.25 %	0.25 %	1 %	2 %
Phase ±(phase error in degree)	1.5 °	0.8 °	0.5 °	2.5 °

Use WCT1000 and LMG specifications to calculate the accuracy of the complete system.

2.15.4 Shield socket

The black socket is internally connected to an electromagnetic shield. If the current transformer is used on high common mode voltage at high frequency, this socked can be connected to earth to conduct the disturbance to earth.

2.16 HF summing current transformer (L95-Z06, -Z06-HV)

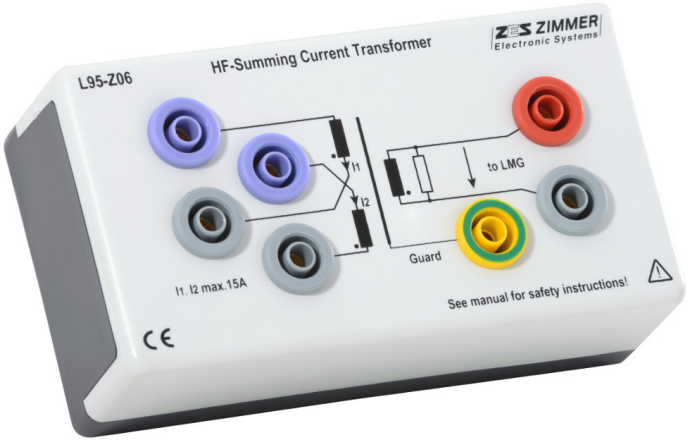

Figure 2.61: HF summing current transformer

Figure 2.62: Highvoltage HF summing current transformer

L95-Z06 is an accessory for the precision power meters LMG with a high bandwidth. It simplifies the measurement of output power in high frequency applications with floating potential. For example: lighting applications, ultrasonic system. The high frequency design provides best accuracy at high frequencies. The current transformer has a voltage output, for the direct connetion to the LMG external Shuntinput.

The high voltage version L95-Z06-HV eliminate the 4mm safety sockets as input terminals. The limited clearances and creepage distances are removed by usage of highvoltage wire. All other specifications are the same as L95-Z06.

The two galvanically separated primary windings are suitable to use in series to increase the sensitivity for small currents. And it can be used as well to build the difference of two (e.g. lamp-) currents. If not needed the second primary winding can be left open.

The guard terminal may be grounded to bypass capacitiv currents from input to output. This reduce errors introduced by common mode voltage.

2.16.1 Safety warnings

- Always connect the sensor first to the meter and earth the guard terminal, and afterwards to the device under test.

- The guard terminal must be grounded to bypass capacitiv currents from input to output. This also reduce errors by common mode voltage.

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

2.16.2 Specifications

Nominal input current	15 A at I1 or I2 or (I1+I2)
Transformer ratio	18 A : 3 V (set scale to 6)
Measuring range	18 A (sum of I1 and I2)
Maximum input	20 A at I1 and 20 A at I2 for 1 s
Bandwidth	5 kHz ... 500 kHz
Output burden	≥100 kΩ
Degree of pollution	2
Temperature range	-10 °C... +50 °C
Output connection	safety sockets 4 mm (use twisted leads to LMG)
Guard connection	safety sockets 4 mm, green / yellow
Size L * W * H	120 mm * 65 mm * 45 mm

(a) L95-Z06

Working voltage	600 V CAT III, 1000 V CAT II
Input connection	safety sockets 4 mm
Weight	200 g

(b) L95-Z06-HV

Working voltage	5 kVrms
Transient overvoltage	10 kVpk
Input connection	free highvoltage wire, approx. 0.8 m
Weight	300 g

2.16.3 Uncertainty

The uncertainties are based on: sinusoidal current, ambient temperature +23±3 °C, calibration interval of 1 year.

Frequency	Amlitude uncertainty in % of measuring value	Phase uncertainty
5 kHz ... 500 kHz	±0.5 %	±1 °

Use L95-Z06 / L95-Z06-HV and LMG specifications to calculate the accuracy of the complete system.

2.16.4 Improving the accuracy due to common mode effects

In high frequency applications with current measurement on high common mode voltage potential it is advantageous to connect the low output of this current transformer with earth. There is a double galvanic separation: in the LMG and inside the current transformer itself. So the secondary side has neither galvanic contact with the load current nor with earth: the current channel is floating on an undefined potential. The high frequency accuracy can be improved by draging down the floating voltage to about earth potential.

2.16.5 Wiring schematics

low current

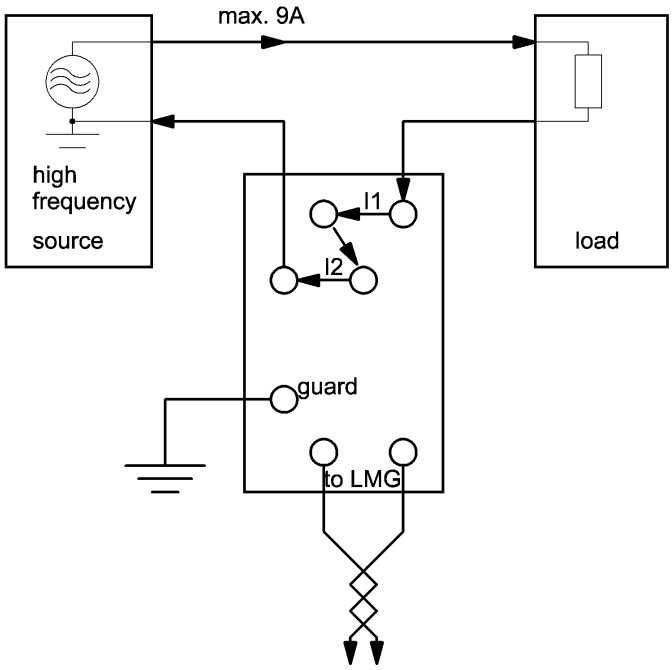

Figure 2.63: low current application

For applications with lower currents use both inputs in series and set the LMG scale to 3.

high current

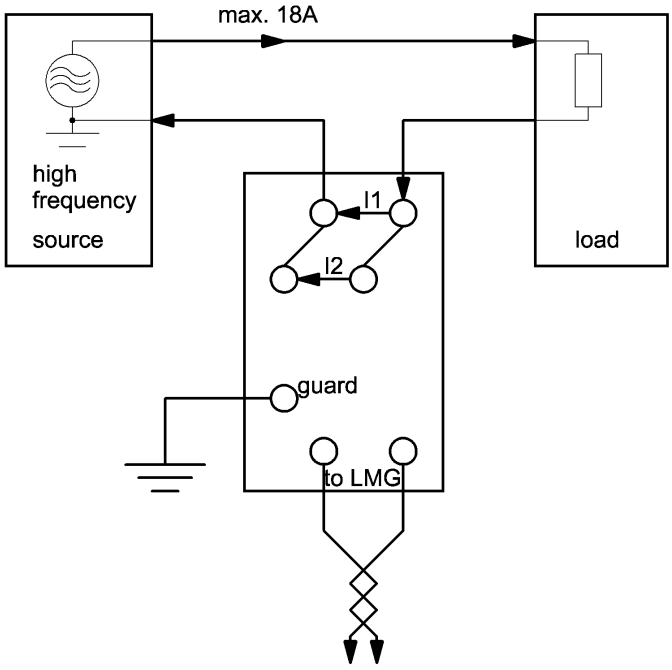

Figure 2.64: high current application

For applications with higher currents use both inputs parallel and set the LMG scale to 6.

arithmetic mean value

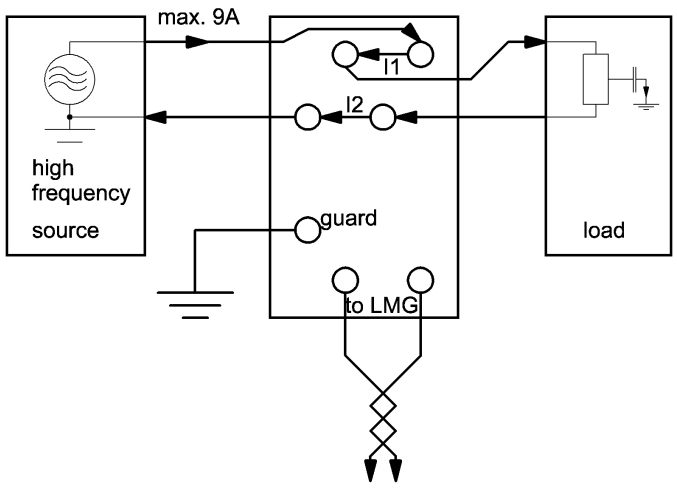

Figure 2.65: arithmetic mean value application

To determine the arithmetic mean value of two currents: $I_{mean} = \frac{I1+I2}{2}$, set the LMG scale to 3. In high frequency lightning applications where a earth current worth mentioning is present, the light density is proportional to the arithmetic mean value of the two currents I1 and I2.

difference of two currents

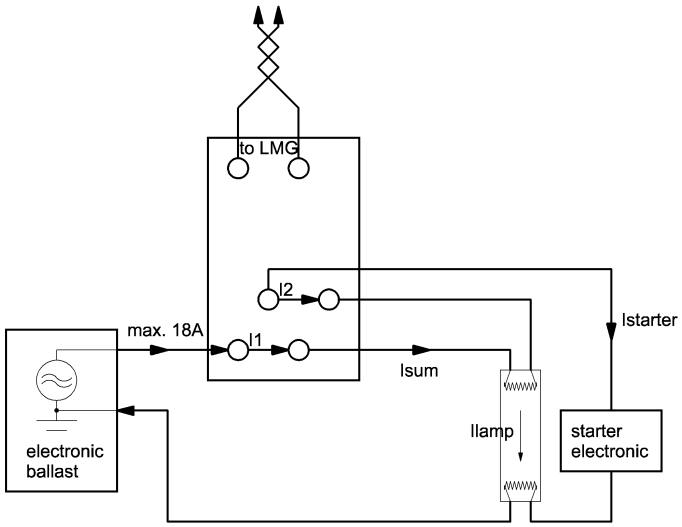

Figure 2.66: difference of two currents

To determine the difference of two currents: $I_{lamp} = I_{sum} - I_{starter}$, set the LMG scale to 6. The lamp current I_{lamp} is the difference of I_{sum} and the current through the starter electronic during the operation.

2.17 Hall effect current sensors (HALL100, -300, -500, -1000, -2000)

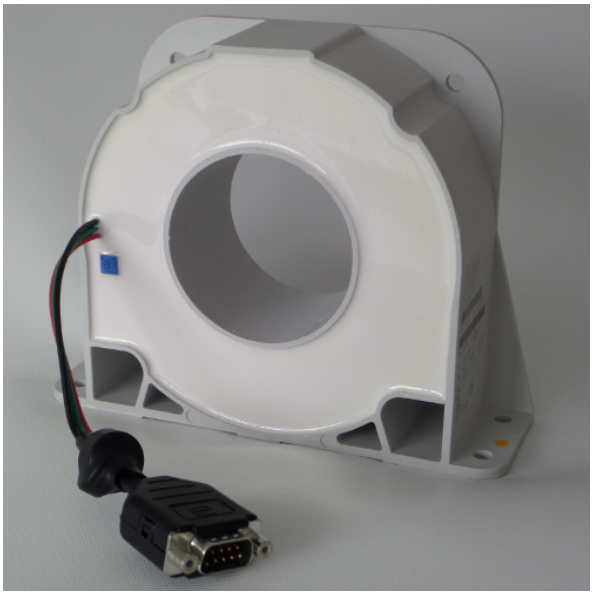

Figure 2.67: Hall effect current sensor

Hall effect sensors with closed-loop technology to measure DC, AC or pulsating currents with a galvanic insulation between primary circuit and power meter.

Typical applications are: frequency inverters, switching power supplies, wind turbines, electric drive systems.

Plastic case and insulating resin are self-extinguishing. RoHS compliant. Fixing holes in the case moulding for horizontal or vertical mounting. Direction of the current: a primary current, flowing in the direction of the arrow marker results in a positive current.

2.17.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact! DSUB9 connector is without safety insulation!
- The operation of the sensor with load current and no concurrent connection to the LMG will cause damage of the sensor and is dangerous for the user!
- Please refer to chapter Safety recommendations [1.2→5]!

2.17.2 Specifications and uncertainty

The uncertainties are based on: calibration interval of 1 year, primary conductor in the middle of the transducer, offset current and thermal drift and di/dt are related to primary current.

Sensor	HALL100	HALL300	HALL500	HALL1000	HALL2000
Nominal input current rms, Ipn	100 A	300 A	500 A	1000 A	2000 A
Maximum input current peak	150 A	500 A	800 A	1500 A	2200 A
Transformation ratio	1000	2000	5000	5000	5000
Secondary current at Ipn	100 mA	150 mA	100 mA	200 mA	400 mA
Maximum input overload	300 A (1 ms/h)	3000 A (10 ms/h)	5000 A (10 ms/h)	10 kA (10 ms/h)	20 kA (10 ms/h)
Accuracy at Ipn, +25 °C	±0.5 %				
Accuracy at Ipn, -5 °C … +70 °C	±1 %				
Accuracy at Ipn, -20 °C … +70 °C	±2.5 %	±1.5 %	±1 %		
Linearity	±0.1 %				
Offset current, +25 °C	±0.4 A	±0.5 A	±1.25 A	±1.25 A	±1.25 A
Thermal drift coefficient -5 °C … +70 °C	±10 mA/°C	±30 mA/°C	±25 mA/°C	±25 mA/°C	±50 mA/°C
Thermal drift coefficient -20 °C … +70 °C	±80 mA/°C	±80 mA/°C	±80 mA/°C	±100 mA/°C	±50 mA/°C
Bandwidth, -1 dB	DC … 100 kHz				
di/dt correctly followed	50 A/µs	50 A/µs	100 A/µs	100 A/µs	100 A/µs
Delay time	≤1 µs				
Dielectric strength, prim./sec.	3 kV (50 Hz, 1 min)				
Operating temperature	-20 °C … +70 °C The temperature of the primary conductor in contact with the case must not exceed +100 °C				
Storage temperature	-40 °C … +85 °C				
Supply voltage	±15 V, ±5 %, internal supply by LMG				
Supply current	120 mA	170 mA	120 mA	220 mA	420 mA
Weight	80 g	140 g	240 g	540 g	1.5 kg

The accuracy of the HALLxx current sensors is determined at different temperature ranges at the nominal current Ipn. The accuracy includes the offset current, the linearity and the thermal drift.

Influence of internal and external magnetic fields:

- The distance to other current sensors carrying a high current, to the current return or other conductors or current bars should be as big as possible, the distance should be at least the diameter of the sensor itself.
- To get the best accuracy, it is recommended to center the primary conductor inside the hole and orientate the sensor in the same direction of the primary conductor.
- The distance from the sensor to magnetic materials (e.g. steel) should be as big as possible. It is better to use non-magnetic materials to fix the sensor.

Use HALLxx and LMG600 specifications to calculate the accuracy of the complete system. See specification of the LMG connection cable regarding the LMG measuring ranges for the calculation.

Example error calculation for DC primary current

Current sensor: HALL100, $T = 25\,°C$, $f = 0\,Hz$, $Ip_{eff} = 50\,A$.

$$\Delta Ip_{eff} = \pm(\text{Linearity} * Ip_{eff} + \text{Offset}) \tag{2.1}$$
$$= \pm(0.1\,\% * 50\,A + 0.4\,A) \tag{2.2}$$
$$= \pm 0.45\,A \tag{2.3}$$
$$\frac{\Delta Ip_{eff}}{Ip_{eff}} = \pm(\frac{0.45\,A}{50\,A} * 100\,\%) \tag{2.4}$$
$$= \pm 0.9\,\% \tag{2.5}$$

Example error calculation for AC primary current

Current sensor: HALL100, $T = 25\,°C$, $f = 50\,Hz$, $Ip_{eff} = 50\,A$.

$$\Delta Ip_{eff} = \pm\left[\text{Linearity} * Ip_{eff} + \left(\sqrt[2]{\text{Offset}^2 + Ip_{eff}^2} - Ip_{eff}\right)\right] \tag{2.6}$$

$$\approx \pm\left[\text{Linearity} * Ip_{eff} + \left(\frac{\text{Offset}^2}{2 * Ip_{eff}}\right)\right] \tag{2.7}$$

$$\approx \pm\left[0.1\,\% * 50\,A + \left(\frac{(0.4\,A)^2}{2 * 50\,A}\right)\right] \tag{2.8}$$

$$\approx \pm 51.6\,mA \tag{2.9}$$

$$\frac{\Delta Ip_{eff}}{Ip_{eff}} = \pm(\frac{51.6\,mA}{50\,A} * 100\,\%) \tag{2.10}$$

$$= \pm 0.1032\,\% \tag{2.11}$$

2.17.3 DSUB9 connector pin assignment of HALLxx

DSUB9 pin	
5	-supply
6	out
9	+supply
1-4, 7-8	nc

2.17.4 Connection of the sensor HALLxx with LMG600

Use HALLxx-K-L6 and L60-X-ADSE and optionally the elongation cable 'LMG-Z-SVTxx' or 'LMG-Z-DV', supply via LMG600. Use LMG connection cable and the current sensor HALLxx with corresponding serial numbers!

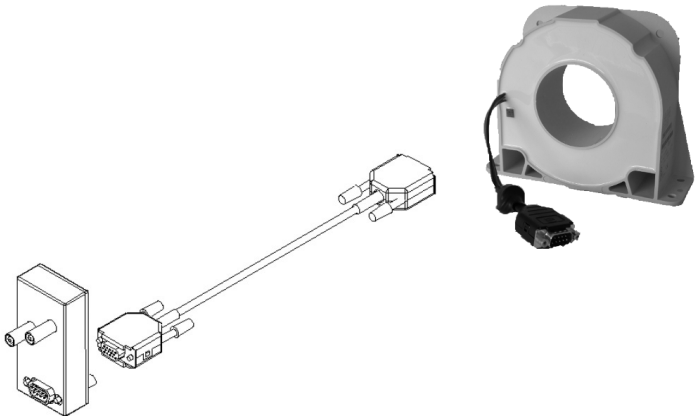

Figure 2.68: HALLxx and HALLxx-K-L6 and L60-X-ADSE

This cable 'HALLxx-K-L6' is used to connect the hall effect current transducer HALLxx to the power meter LMG600. Internal electronic of the connector to the LMG600 contains the adjustment data of the hall effect current transducer as well as measuring ranges, sensor name and serial number. This data is read out of the sensor automatically.

Connection

- switch all power off
- plug the 'HALLxx-K-L6' cable connector labeled 'HALLxx' to the current sensor

- plug the 'HALLxx-K-L6' cable connector labeled 'LMG600' to the adapter L60-X-ADSE mounted on the LMG600 current channel
- now switch on the power and begin your measurements - the power of the equipment under test should be switched on at least!

Measuring ranges LMG600 with HALL100

Nominal range / A	5	10	20	40	80	100
Max. TRMS value / A	5.5	11	22	44	88	100
Max. peak value / A	14	28	56	112	150	150
Range peak value for accuracy calculation / A	14	28	56	112	224	469

Measuring ranges LMG600 with HALL300

Nominal range / A	10	20	40	80	160	300
Max. TRMS value / A	11	22	44	88	176	300
Max. peak value / A	28	56	112	224	448	500
Range peak value for accuracy calculation / A	28	56	112	224	448	938

Measuring ranges LMG600 with HALL500

Nominal range / A	25	50	100	200	400	500
Max. TRMS value / A	27.5	55	110	220	440	500
Max. peak value / A	70	140	280	560	800	800
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345

Measuring ranges LMG600 with HALL1000

Nominal range / A	25	50	100	200	400	750	1000
Max. TRMS value / A	27.5	55	110	220	440	825	1000
Max. peak value / A	70	140	280	560	1120	1500	1500
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345	4690

Measuring ranges LMG600 with HALL2000

Nominal range / A	25	50	100	200	400	750	1500	2000
Max. TRMS value / A	27.5	55	110	220	440	825	1650	2000
Max. peak value / A	70	140	280	560	1120	2200	2200	2200
Range peak value for accuracy calculation / A	70	140	280	560	1120	2345	4690	9375

Since the 'max. peak value' is limited by the LMG ranges as well as the current sensor, please use 'range peak value for accuracy calculation' to determine the LMG600 accuracy.

Connection elongation

To use the current sensor with a larger connection length between power meter and HALLxx connect a well shielded extention cable between the HALLxx (DSUB9f plug) and the HALLxx-K-L6 connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES ZIMMER: 'LMG-Z-SVTxx' or 'LMG-Z-DV' in different lenths from 5m to 50m. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

3 Accessories

3.1 PCT current sensor supply unit (PCTSIU4)

Figure 3.1: PCTSIU4

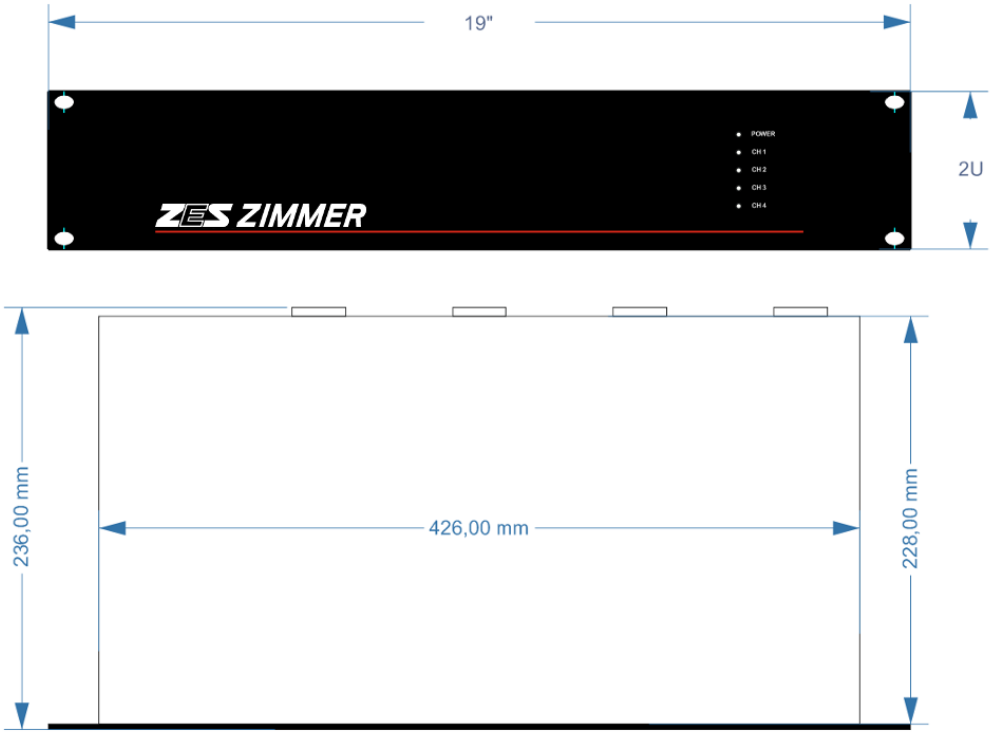

Figure 3.2: PCTSIU4 mechanical dimensions

Figure 3.3: PCTSIU4 back side

The sensor supply unit PCTSIU4 is intended to be used for powering up to four precision current transducers PCT200, PCT600 and PCT2000.

3.1.1 Safety warnings

- Do not power up the device before all cables are connected.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!
- Do not disassemble the unit.
- Make sure that the unit is properly connected to earth ground.
- Do not block the ventilation openings on the side panels.
- If the fan does not operate properly contact the manufacturer for repair.
- If the 'power' green diode is not working when mains is applied, disconnect power and contact the manufacturer for further instruction.

3.1.2 Specifications

Mains voltage	100 V ... 240 V
Mains frequency	47 Hz ... 63 Hz
Channels	4 x PCT200 or PCT600 or PCT2000
Output voltage	±15 V ... ±15.75 V
Safety	EN 61010-1:2010
EMC	EN 61326-1

3.1.3 Installation

Grounding the transducer head is strictly recommended! Even if there is no requirement for safety ground on the product, for safety reasons the transducer head PCT is strictly recommended to be connected to earth ground! If in case of damage in the installation a bare conductor connects the aluminium housing this will prevent the transducer head and the LMG connection cable to be energised. Connect the earth wire to the transducer head PCT using a ring terminal and a toothed locked washer designed for the maximun short circuit current of the installation, fastened to one of the 6.5 mm mounting holes. Grounding of the transducer head PCT is also recommended to lead away capacitive coupled distortion.

Also if bare conductors can be used up to the above values, it is strictly recommended to use insulated conductors only. By this is prevented, that the housing of a transducer might short circuit

two conductors. Further more there are no problems when the secondary cable touches a primary conductor.

Do not power up the device before all cables are connected.

Connect the PCT-DSUB cable between supply unit and the sensor.

Connect an instrument with low impedance current path on the secondary output (4mm red and black connectors).

When all connections are secured - connect mains power.

When mains is applied a green light diode at the front next to symbol 'power' will light green. For each sensor connected a green light diode will light on the front if the connection is correct and the sensor is operating within normal range.

3.1.4 Package content

- PCTSIU4 supply unit
- Europe power cable and US/Asia power cable
- 4 x rubber feet for table use
- 4 x rack screw kits for 19" rack mount

3.1.5 Accessories

Connection cable PCT-DSUB, between Precision current transducers PCT and PCTSIU4. Available cable lengths: 2m, 5m, 10m, 20m (20m not for PCT2000!).

3.2 Shielded PCT connection cable (PCT-DSUB)

Figure 3.4: Shielded PCT connection cable

This is a high quality, well shielded PCT connection cable with a high immunity against EMC. It is intended to be used to connect PCT200, PCT600 or PCT2000 to the supply unit PCTSIU4. It is available in different lengths: 2 m, 5 m, 10 m and 20 m.

3.2.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extention cable and hazardous voltages!
- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!

3.2.2 Specifications

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 male, DSUB9 female
Connection	1:1, but pin2 and pin7 not connected!
Operating temperature	-5 °C... +70 °C
Voltage drop	PCT-DSUB2: max. 0.24 V @ 1 A PCT-DSUB5: max. 0.45 V @ 1 A PCT-DSUB10: max. 0.8 V @ 1 A PCT-DSUB20: max. 1.5 V @ 1 A (not for PCT2000)
Cable length	PCT-DSUB2: 2 m PCT-DSUB5: 5 m PCT-DSUB10: 10 m PCT-DSUB20: 20 m (not for PCT2000)

3.3 LMG600 current sensor adapter (L60-X-ADSE)

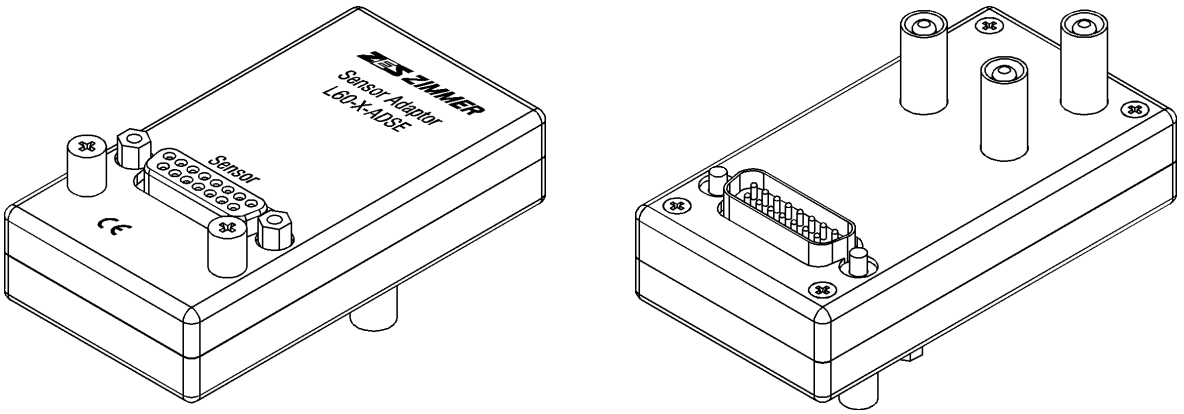

Figure 3.5: L60-X-ADSE

The special design of all LMG600 sensors makes them very easy and comfortable to use. The DSUB15 plug contains the identification of the sensor type, the measuring ranges, including the needed scaling and several more parameters. The LMG600 reads this values and the meter will automatically be configured to the optimum adjustments for using this special sensor. The LMG range setup is automatically taken from the sensor EEPROM. Further on we correct some of the sensor errors (transfer error, delay time, ...). So you get the best measuring results with each sensor.

For all special LMG600 sensors the Adapter L60-X-ADSE is needed, because internally it is necessary to connect the system ground (CPU, Sensor supply, ...) with the ground of the measuring channel. Both signals are connected with a DSUB15 plug, without galvanic separation. The adapter L60-X-ADSE guarantees that no measuring leads are connected to the measuring channel at the same time and prevents electrical shock.

3.4 Artificial mid point (LMG-Z-AMP)

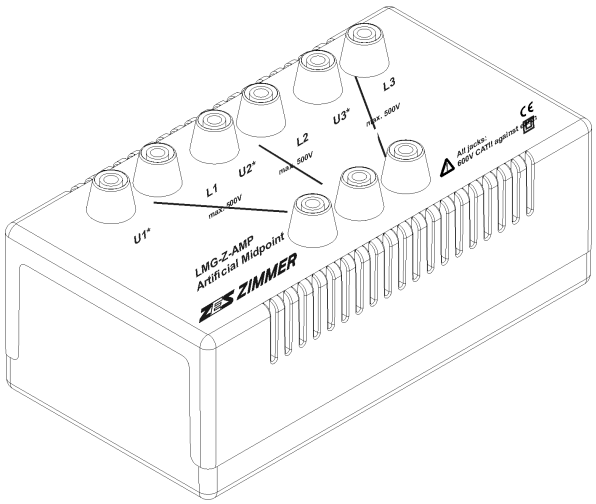

Figure 3.6: LMG-Z-AMP

When measuring at three-phase systems without accessible star point (typical for frequency inverters), an artificial star point is needed for measurements in star connections. If necessary, the losses of the artificial star point have to be considered. They can be determined exactly. The formula editor can be used to automatically calculate these losses and correct them.

3.4.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Please refer to chapter Safety recommendations [1.2→5]!

3.4.2 Connection to LMG

The LMG-Z-AMP is connected to the LMG using the six cables of the LMG (3x black, 3x yellow). Connect each channel U with U and U* with U*. At the L1, L2, L3 jack you can connect your voltage via the three delivered yellow measuring leads. The three black sockets U1, U2 and U3 (they represent the artificial mid point) are interconnected!

3.4.3 Specifications

Umax line-to-neutral	500 V
Umax against earth	600 V
Rtyp	65.8 kΩ
Accuracy of the phase resistors in relation to each other	±0.01 %
Weight	220 g
Dimensions	150 mm * 80 mm * 65 mm

3.5 Adaptor for measurement at Schuko devices (LMG-MAS)

Figure 3.7: LMG-MAS

The MAS is a adaptor for measuring at single phase devices with Schuko inlet connector up to 16A. It was developed for the instrument series LMG. The supply is done by the fix mounted Schuko inlet. The load is connected to the fixed mounted Schuko jack. With the LMG-MAS you can measure the voltage (jacks U and U*). The current is also accessable (from I* to I). This jacks have to be connected to the jacks of the measuring instrument.

The internal wiring is done so that the load is measured with correct current. This wiring is perfect suited for the measurement of stand by power. An important point is the safety. The MAS is in compliance with IEC61010-1 and was constructed for voltages up to 250 V CAT II.

3.5.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.
- Attention! The PE jack should not be used for earthing external devices. It is only allowed to use it for measuring purposes.
- Important! If you dont want to measure the current, the jacks I* and I have to be short circuit to enable the current to flow.
- Please refer to chapter Safety recommendations [1.2→5]!

3.5.2 Specifications

Rated voltage	250 V CAT II
Rated current	16 A

3.6 Adaptor for measurement at IEC connector devices (LMG-MAK1)

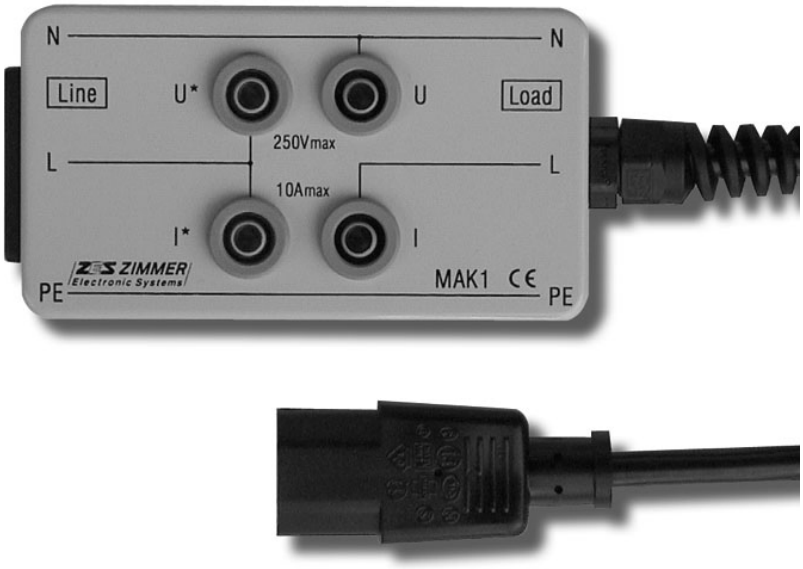

Figure 3.8: LMG-MAK1

The MAK1 is an adaptor for measuring at single phase devices with IEC inlet connector up to 10 A. It was developed for the instrument series LMG. The supply is done by a IEC inlet cord which must be connected to the MAK1. The load is connected by the fixed mounted cord. With the MAK1 you can measure the voltage (jacks U and U*). The current is also accessable (from I* to I). This jacks have to be connected to the jacks of the measuring instrument.

The internal wiring is done so that the load is measured with correct current. This wiring is perfect suited for the measurement of stand by power.

An important point is the safety. The MAK1 is in compliance with IEC61010-1 and was constructed for voltages up to 250 V CAT II.

3.6.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.
- Important! If you dont want to measure the current, the jacks I* and I have to be short circuit to enable the current to flow.
- Please refer to chapter Safety recommendations [1.2→5]!

3.6.2 Specifications

Rated voltage	250 V CAT II
Rated current	10 A

3.7 Adaptor for measurement at 16A / 3-phase devices (LMG-MAK3)

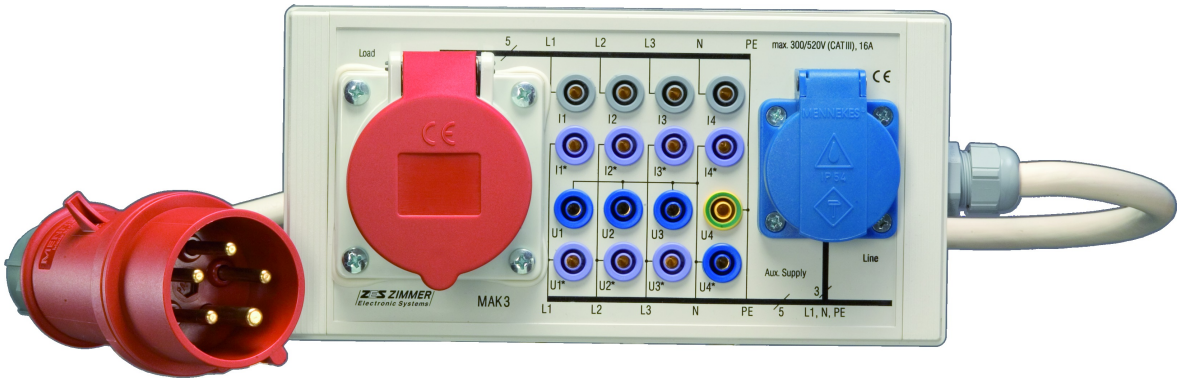

Figure 3.9: LMG-MAK3

The MAK3 is an adaptor for measuring at 3 phase systems up to 16A per phase. It is developed for the instrument series LMG, but you can also connect other instruments.

The supply is done by a about 2m long wire. The schuko jack is to supply the instrument. If you are measuring a load, the power consumption of the instrument is not taken into account, because it is supplied before the measuring connectors. If you are measuring a generator, you should supply the instrument from another jack to avoid measuring errors. With the MAK3 you can measure the voltage of the three phases (jacks U1*, U2* and U3*) against the neutral connector (U1, U2 and U3). But you can also measure the linked voltages. The three currents are also accessable (from I1*, I2 * and I3* to I 1, I2 and I3). Further on by using a 4-channel instrument you can measure the voltage between neutral and earth (U4* against U4) as well as the current in the neutral (I 4* to I 4).

3.7.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.
- Attention: Ensure in any case, that the N (neutral) on the patch panel is connected from the input side to the output side! Either via a current measurement path or with a short circuit on the patch panel. An open N (neutral) can lead to dangerous voltage at the output and may destroy the connected load!! If you dont want to measure the current in L1, L2 or L3, the jacks Ix* and Ix have to be short circuit to enable the current to flow!
- Please refer to chapter Safety recommendations [1.2→5]!

3.7.2 Specifications

Rated voltage	240 V / 415 V CAT II
Rated current	16 A

3.8 Adaptor for measurement at 32A / 3-phase devices (BOB-CEE3-32)

Figure 3.10: BOB-CEE3-32

The BOB-CEE3-32 is an adaptor designed for measuring up to 32A per phase in 3-phase systems. It was developed for the instrument series LMG, but third-party instruments may be connected as well.

The BOB-CEE3-32 allows measurement of the voltage of each of the three phases (jacks L1, L2 and L3) against the neutral jacks and each of the three currents (I1, I2 and I3). By using a 4-channel instrument, the voltage between neutral and earth (N against ⏚) can be measured, as well as the current in the neutral (IN). It also allows measurement of the linked voltages. The adaptor is standard equipped with a jumper in the neutral path, which enables the current to flow. The length of the supply cable is about 2m.

The Schuko jack (Aux. Supply) can be used to supply the instrument and other equipment (e.g. laptop computer). For safety purpose, this Schuko jack is equipped with a standard 16A circuit breaker. If a load is measured, the power consumption of the instrument is not taken into account, as it is supplied before the measuring connectors. If a generator is measured, the instrument should be powered from a separate jack in order to avoid measuring errors.

3.8.1 Safety warnings

- Always connect the adaptor first to the meter and afterwards to the device under test.
- Attention: Ensure in any case, that the N (neutral) on the patch panel is connected from the input side to the output side! Either via a current measurement path or with a short circuit on the patch panel. An open N (neutral) can lead to dangerous voltage at the output and may destroy the connected load!! If you dont want to measure the current in L1, L2 or L3, the jacks Ix* and Ix have to be short circuit to enable the current to flow!
- Please refer to chapter Safety recommendations [1.2→5]!

3.8.2 Specifications

Rated voltage	230 V / 400 V CAT II
Rated current	32 A

3.9 Safety laboratory leads (LMG-Z307, -Z308, -Z309, -Z310, -Z311)

Figure 3.11: Safety laboratory leads for current path

Figure 3.12: Safety laboratory leads for voltage path

Figure 3.13: Safety laboratory lead for general purpose

Safety laboratory leads for voltage and current measurement. The blue cable for general purpose can be used for example to short circuit the voltage channels at zero adjustment or for star/delta wiring.

3.9.1 Safety warnings

- Please refer to chapter SAFETY RECOMMENDATIONS [1.2→5]!
- The yellow and black voltage cables have each an implemented fuse. Before and after each measurement: Check the fuse! To replace this fuse, remove the cable on both sides from all circuits to make it free of dangerous voltages. Disassemble the fuse holder. Replace the fuse only with the specified type. Reassemble the fuse holder.

3.9.2 Specifications

Color	grey and violet
Length	LMG-Z307I: 0.25 m LMG-Z308I: 1.5 m LMG-Z309I: 3 m LMG-Z310I: 6 m LMG-Z311I: 10 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C... +70 °C
Cable	PVC double-insulated
Contact parts	nickel-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	2.5 mm^2
Rated current	32 A

Table 3.3: Safety laboratory leads for current path

Color	black and yellow
Length	LMG-Z308U: 1.5 m LMG-Z309U: 3 m LMG-Z310U: 6 m LMG-Z311U: 10 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C... +70 °C
Cable	PVC double-insulated
Contact parts	nickel-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	1 mm^2
Fuse	6.3x32 mm, FF 500 mA, 1000 V, AC+DC, 30 kA breaking capability e.g. SIBA 7017240.0,5

Table 3.4: Safety laboratory leads for voltage path

Color	blue
Length	LMG-Z307NSB: 0.25 m
Measurement category	1000 V / CAT III
Temperature range	-10 °C... +70 °C
Cable	PVC double-insulated
Contact parts	nickel-plated
Sleeves	PA6.6 (Polyamid)
Copper cross section	2.5 mm^2
Rated current	32 A

Table 3.5: Safety laboratory leads for general purpose

3.10 Safety jaw clip for current and voltage connection (LMG-Z301)

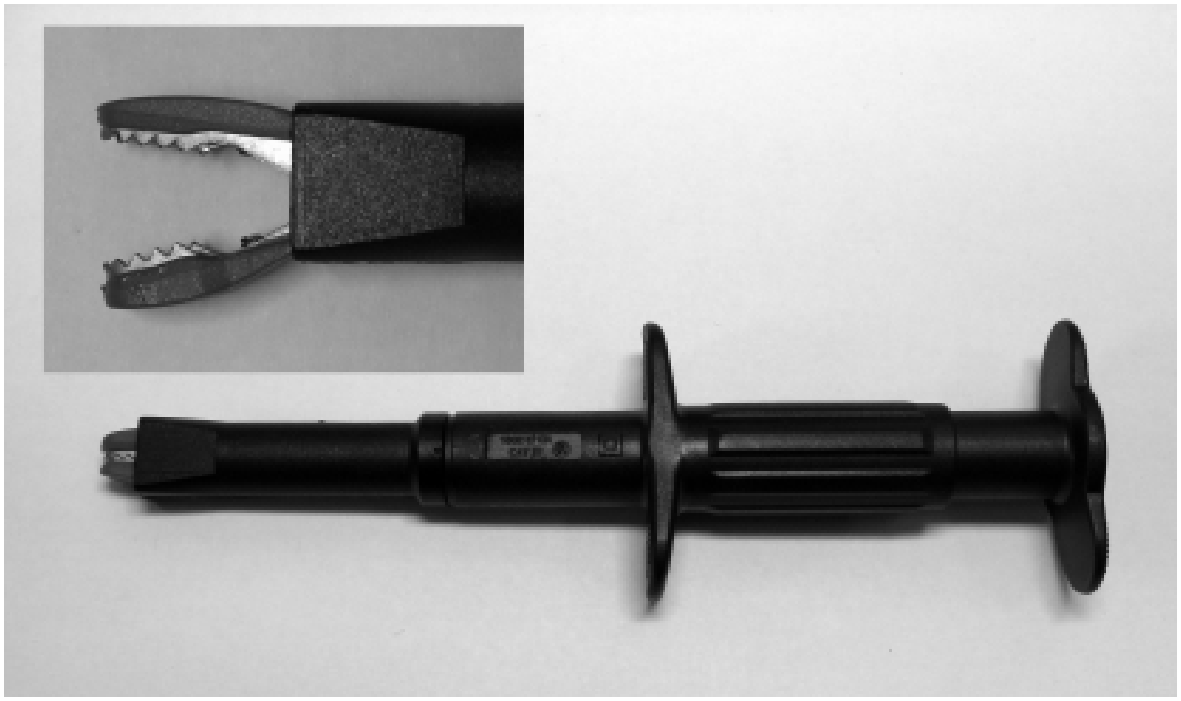

Figure 3.14: LMG-Z301 black

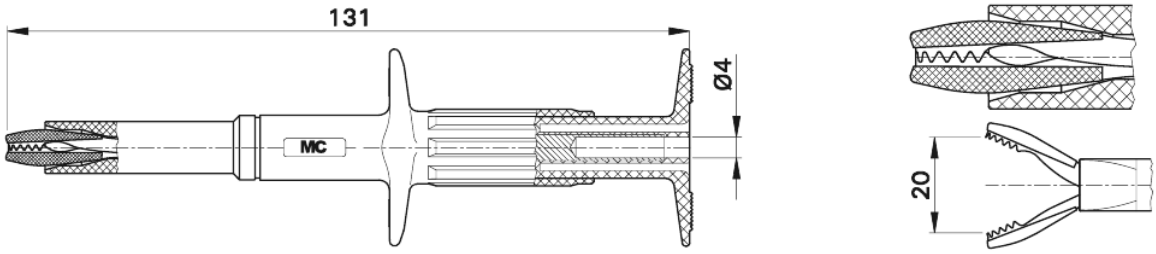

Figure 3.15: Dimensions of LMG-Z301

Test clips for current and voltage connection with on the outside insulated steel jaws.

3.10.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

3.10.2 Specifications

Rated voltage	1000 V, CAT III
Rated current	16 A
Operating temperature	-40 °C … +80 °C
Output connection	safety socket 4mm
Available are:	LMG-Z301 red LMG-Z301 black

3.11 Shielded DSUB9 extention cable (LMG-Z-DV)

Figure 3.16: Shielded DSUB9 extention cable

This is a high quality very well shielded DSUB9 extention cable, high immunity against EMC. It is screwable with UNC4-40 threads at both connectors.

It can be used to extend the cable length of the PSU and PCT connection cables. In this case it is used between the precision current sensor PSU60/200/400/600/700/1000 or PCT200/600 and the LMG specific connection cable to the LMG.

3.11.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extention cable and hazardous voltages!
- Please refer to chapter Safety recommendations [1.2→5]!

3.11.2 Specifications

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 male / DSUB9 female
Operating temperature	-5 °C... +70 °C
Cable length	LMG-Z-DV3: 3 m LMG-Z-DV5: 5 m LMG-Z-DV10: 10 m LMG-Z-DV15: 15 m

3.12 Shielded Sensor extenion cable with extended temperature range (LMG-Z-SVT)

Figure 3.17: Shielded Sensor extention cable with extended temperature range

This is a high quality very well shielded Sensor extention cable, high immunity against EMC. It is screwable with UNC4-40 threads at both connectors. The cable is halogen-free.

It can be used to extend the cable length of the PSU and PCT connection cables. In this case it is used between the precision current sensor PSU60/200/400/600/700/1000 or PCT200/600 and the LMG specific connection cable to the LMG.

All pins are connected 1:1 except pin2 and pin7, they are left open for the use with current sensors PSU and PCT. This sensor extention cable will not do the job as a RS232 connection cable!

3.12.1 Safety warnings

- Attention: No safety insulation, working voltage max. 50 V, when using Busbar without insulation or other not insulated items, assure safety distance between the extention cable and hazardous voltages!
- Please refer to chapter Safety recommendations [1.2→5]!

3.12.2 Specifications

Insulation	No safety insulation, working voltage max. 50 V
Connectors	DSUB9 male / DSUB9 female
Operating temperature	-40 °C... +90 °C
Cable length	LMG-Z-SVT5: 5 m LMG-Z-SVT10: 10 m LMG-Z-SVT15: 15 m

3.13 DSUB Adapter with screwed terminal connection (LMG-DSUBIO)

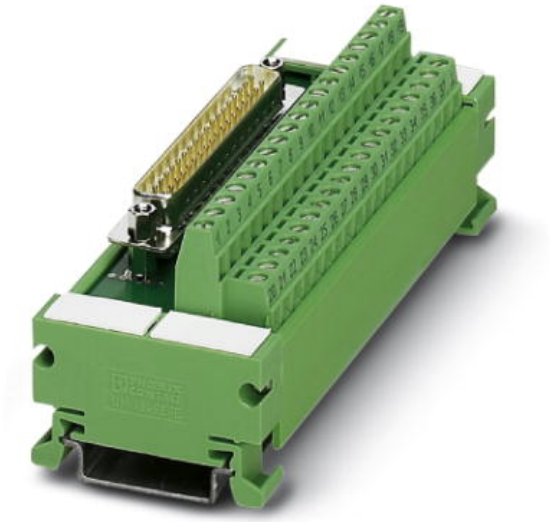

Figure 3.18: LMG-DSUBIO (picture similar)

Adapter from DSUB to screwed terminal connection for easy access to LMG process signal interface and external synchronisation.

For assembly on DIN rail NS35/7.5.

3.13.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

3.13.2 Specifications

Conductor cross section min.	0.14 mm^2 / AWG26
Conductor cross section max.	1.5 mm^2 / AWG16
Stripping length	6 mm
Screw thread	M3
Max. current per branch	1.5 A
Operating temperature	-20 °C ... +50 °C
Storage temperature	-20 °C ... +70 °C
Available are:	LMG-DSUBIO25M for DSUB25f (LMG600 process signal interface), including 2m connection cable DSUB25f to DSUB25m
	LMG-DSUBIO15M for DSUB15f (LMG600 process signal interface), including 2m connection cable DSUB15f to DSUB15m
	LMG-DSUBIO15F for DSUB15m (LMG600 external sync), including 2m connection cable DSUB15f to DSUB15m
	LMG-DSUBIO9M for DSUB9f (LMG600 process signal interface) including 2m connection cable DSUB9f to DSUB9m

3.14 IEEE488 bus cable (LMG-Z312, -Z313, -Z314)

Figure 3.19: IEEE488 bus cable

IEEE 488 bus cable, full screened metal-plug socket case to maintain the excellent noise immunity of all LMG instruments.

Cable length:

- LMG-Z312: 1 m
- LMG-Z313: 2 m
- LMG-Z314: 4 m

3.14.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

3.15 RS232 interface cable (LMG-Z317)

Figure 3.20: RS232 interface cable

RS232 interface cable, DSUB 9 male to DSUB 9 female, 1:1 connection, length about 1.8m.

3.15.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

3.16 LMG600 connection cable for current sensors PSU (PSU-K-L6)

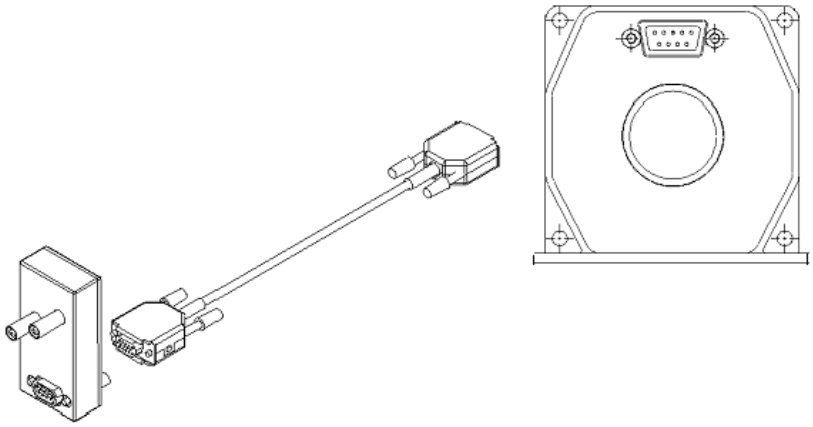

Figure 3.21: PSU-K-L6 (shown together with L60-X-ADSE and transducer head PSU)

The LMG600 connection cable PSU-K-L6 is for the connection of discontinued precision current transducers series PSU. It is not recommended for new projects, but for the use of previously purchased LMG500 transducers. PSU-K-L6 is a generic cable for the supply and measurement of the current output of PSU60, PSU200, PSU200HF, PSU400, PSU700 and PSU1000HF with the I* ranges of LMG600 series. The Iscale of the corresponding current channel has to be set to the below given values. No calibration data, range information, serial number and sensor name is stored in the cable. No additional error terms of the cable have to be considered. If a calibration protocol is required, the precision current transducer PSU is calibrated without this cable.

PSU600 is not pin-compatible to PSU-K-L6, please connect this transducer to LMG600 via SSU4 and PSU-K3/K5/K10 and SSU4-K-L31.

For new projects, please see precision current transducers series PCT.

3.16.1 Safety warnings

- Always connect the sensor first to the meter and afterwards to the device under test.
- Attention: when using busbar without insulation, regard DSUB cable insulation or aviod contact!
- Please refer to chapter Safety recommendations [1.2→5]!

3.16.2 Specifications and uncertainty

For the specifications and uncertainty see the datasheet of the precision current transducer PSU and use the below given measuring ranges of LMG600 to calculate the accuracy of the complete system.

3.16.3 Connection and supply of current sensors PSU with LMG600

Use PSU-K-L6 and L60-X-ADSE, supply via LMG600. PSU-K-L6 is a generic connection cable for PSU60, PSU200, PSU200HF, PSU400, PSU700 and PSU1000HF with different current consumption, therefore there is no sensor supply current monitoring by LMG600. Please regard that that the amount of supply current for all current sensors does not exceed the supply capability from the LMG! See following table.

supply capability (for all current sensors) of LMG670	5 A
supply current of PSU60	180 mA
supply current of PSU200/200HF/400	280 mA
supply current of PSU700	480 mA
supply current of PSU1000HF	1.08 A

Measuring ranges LMG600 with PSU60

Set Iscale to 600. Limited by PSU60 to 'Max. TRMS value' = 60 A and 'Max. peak value' = 60 A.

Nominal range / A	3	6	12	24	48	(90)	...
Max. TRMS value / A	3.3	6.6	13.2	26.4	52.8	(99)	...
Max. peak value / A	8.4	16.8	33.6	(67.2)	(134.4)	(281.4)	...

Measuring ranges LMG600 with PSU200 / PSU200HF

Set Iscale to 1000. Limited by PSU200 / PSU200HF to 'Max. TRMS value' = 200 A and 'Max. peak value' = 200 A.

Nominal range / A	5	10	20	40	80	150	(300)	...
Max. TRMS value / A	5.5	11	22	44	88	165	(330)	...
Max. peak value / A	14	28	56	112	(224)	(469)	(938)	...

Measuring ranges LMG600 with PSU400

Set Iscale to 2000. Limited by PSU400 to 'Max. TRMS value' = 400 A and 'Max. peak value' = 400 A.

Nominal range / A	10	20	40	80	160	300	(600)	...
Max. TRMS value / A	11	22	44	88	176	330	(660)	...
Max. peak value / A	28	56	112	224	(448)	(938)	(1876)	...

Measuring ranges LMG600 with PSU700

Set Iscale to 1750. Limited by PSU700 to 'Max. TRMS value' = 700 A and 'Max. peak value' = 700 A.

Nominal range / A	8.75	17.5	35	70	140	262.5	525	(1050)	...
Max. TRMS value / A	9.625	19.25	38.5	77	154	288.75	577.5	(1155)	...
Max. peak value / A	24.5	49	98	196	392	(820.75)	(1641.5)	(3281.25)	...

Measuring ranges LMG600 with PSU1000HF

Set Iscale to 1000. Limited by PSU1000HF to 'Max. TRMS value' = 1000 A and 'Max. peak value' = 1000 A.

It is possible to supply up to four PSU1000HF from LMG600. If more PSU1000HF are needed, please use sensor supply unit SSU4 with modification for PSU1000HF and PSU-K3/K5/K10 and SSU4-K-L31.

Nominal range / A	5	10	20	40	80	150	300	600	(1200)	...
Max. TRMS value / A	5.5	11	22	44	88	165	330	660	(1320)	...
Max. peak value / A	14	28	56	112	224	469	938	(1875)	(3750)	...

3.16.4 Connection elongation

To use the current sensor with a larger connection length between power meter and PSU connect a well shielded extention cable between the PSU (DSUB9f plug) and the PSU connection cable (DSUB9m plug) and screw both plugs together. This extention cable is available at ZES ZIMMER: 'LMG-Z-SVT' or 'LMG-Z-DV' in different lenths from 5m to 50m. Interference from strong electromagnetical disturbed environments may affect the measurement accuracy. This depends from the respective installation in the complete system and is out of responsibility of ZES ZIMMER.

3.17 Insulated 4 mm connecting plug (LMG-SCP)

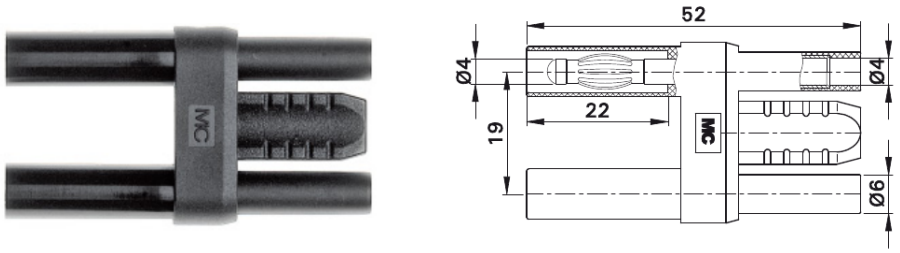

Figure 3.22: LMG-SCP

Insulated 4 mm connecting plug, made of brass. Plugs with spring-loaded Multilams and rigid insulating sleeves. With insulated grip and with two in-line 4 mm rigid sockets accepting spring-loaded 4 mm plugs with rigid insulating sleeve. Plug spacing 19 mm.

This plug can be used for the short circuit at zero adjustment, for test measurements of common-mode rejection and for the current connection on the patch panel of LMG-MAS / LMG-MAK1 / LMG-MAK3 and BOB-CEE3-32.

3.17.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

3.17.2 Specifications

Rated voltage	1000 V, CAT II
Rated current	32 A
Plug spacing	19 mm

3.18 Strain-relief for current and voltage leads (LMG-STR)

Figure 3.23: screw mounted cable clamps

Figure 3.24: screw mounted cable tie mounts

Strain-relief for current and voltage leads mounted on LMG600 series power measurement channel. This is useful to prevent the signal from being accidentally interrupted.

Package consists of a set of 14 screw mounted cable tie mounts (PA 6.6) and alternative screw mounted cable clamps (PA 6.6) along with screws M4. Please use the M4 nut assigned to the current terminals to fix the current leads and the M4 nut assigned to the voltage terminals to fix the voltage leads. The diameter of the screw to be used must conform to M4 and the maximum length of the part to be inserted into the instrument must not exceed 7 mm.

Either the screw mounted cable tie mounts or the screw mounted cable clamps can be used for current or voltage leads depending on the cable diameter.

3.18.1 Safety warnings

- Please refer to chapter Safety recommendations [1.2→5]!

4 FAQ - frequently asked questions / Knowledge base

4.1 Avoid distortion when using external sensors in noisy environment

External current sensors with voltage output connected to the precision power meter series LMG have usually an output voltage of a few mV to several V. This sensors can be connected to the LMG Isensor input and current measurements can be done with a high accuracy, but a few points have to be kept in mind. Also sensors with current output can have distortion problems. Especially in EMC noisy environments with high dU/dt voltages the following points should be considered to achieve best accuracy and low noise:

- Use well shielded coaxial cable to connect sensors with voltage output to the power meter LMG. Sensors with current output should be connected with twisted measuring leads.

- Avoid ground loops, do not connect the shield and/or housing of the sensor at several different points to earth. Take into concern, that other instruments, measuring the same secondary signal, might have inputs without isolation to earth, e.g. oscilloscopes. Important is the star-shaped grounding of the complete system.

- In the case of well shielded sensors e.g. Pearson transducers, the shield housing should be connected to PE to allow the capacitiv coupled distortion to find a low impedance way to earth and do not couple to the measuring signal. If so, the low input I should not be connected to earth.

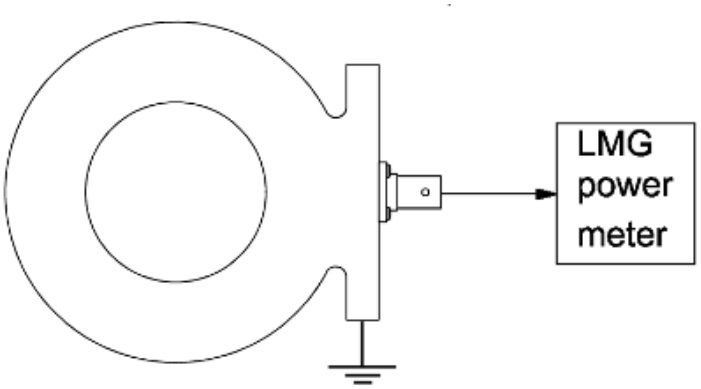

Figure 4.1: Grounding of well shielded sensors

- In applications with current measurement on high common mode voltage potential it is advantageous to connect the low output of a galvanic separated current transformer with earth. There is a double galvanic separation: in the LMG and inside the current transformer itself. So the secondary side has neither galvanic contact with the load current nor with earth: the current channel is floating on an undefined potential. The accuracy can be improved by draging down the floating voltage to about earth potential and give the distortion currents a low impedance way to earth.

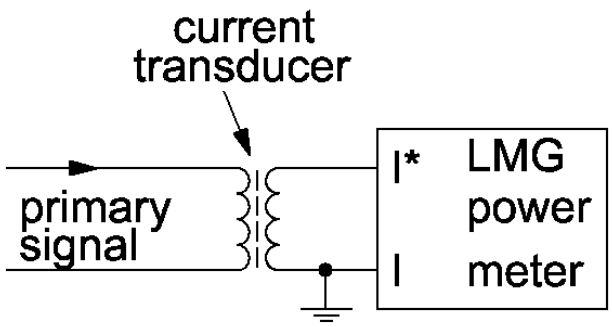

Figure 4.2: Grounding of common current sensor signals

- In applications with a high dU/dt and sensors with onboard electronics it might be profitable to shield the isolated primary conductor e.g. with copper foil connected only at one side! to earth. This shield ought to bleed of the capacitive coupled distortion to earth and keep them away from the sensor electronics. This policy can also be used to enhance accuracy and reject distortion with other current transducers.

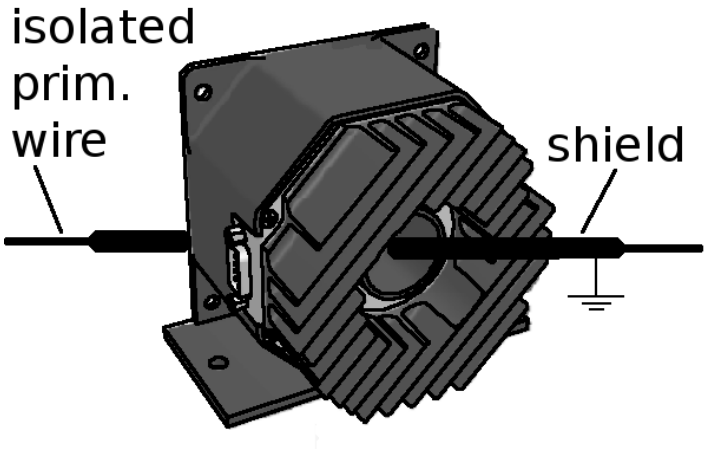

Figure 4.3: Grounding of sensors with onboard electronics

- In all cases you should adapt the bandwidth of the power meter to the bandwidth of the current sensor and the signal. It is useless to measure the active power with a 5 kHz bandwidth current clamp and a power meter bandwidth of 10 MHz, in this case a signal filter of e.g. 10 kHz will not affect the measuring signal significantly, but will highly reduce HF distortion and noise!

4.2 How to connect and supply PCT with LMG600

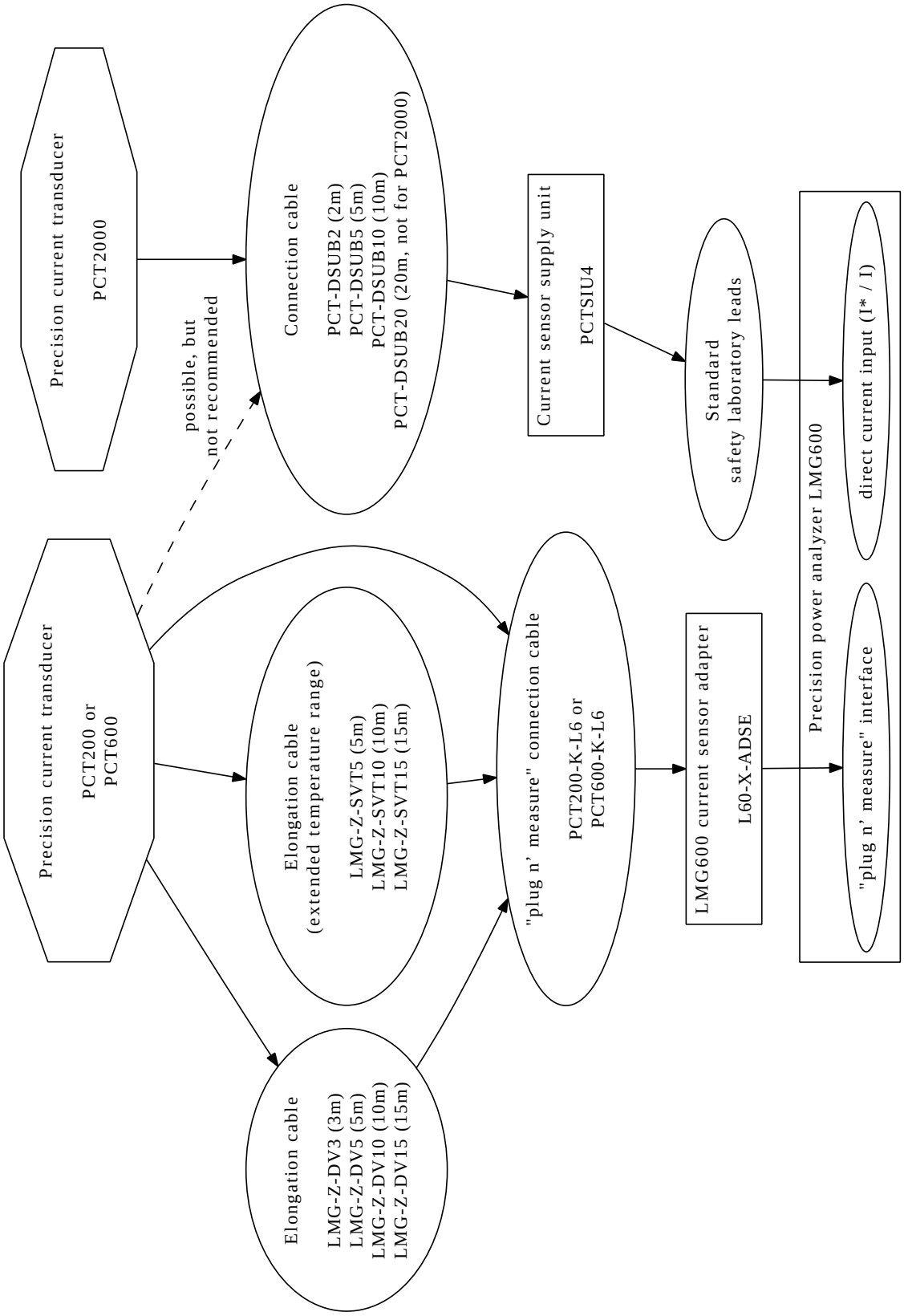

Figure 4.4: How to connect and supply PCT with LMG600

4.3 Avoid measuring errors due to shield currents

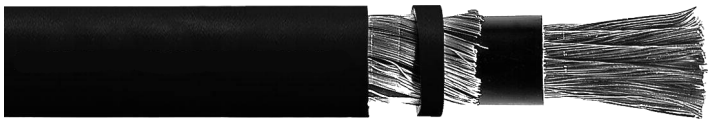

Figure 4.5: shielded high voltage cable

In the medium voltage range (e.g. wind energy) and also electrically powered vehicles shielded cabels are commonly used for power connections.

Current measurement with feed-through current transducers and shielded cables can lead to measuring errors. Only the current in the inner conductor is relevant but its magnetic field is superimposed with the magnetic field of the shield current and measured together in the current transducer.

The shield turned back through the transducer will lead to an opposite magnetic field and cancels the resulting magnetic field measured by the transducer to zero. The shield effect against the electric field between conductor and transducer is not influenced.

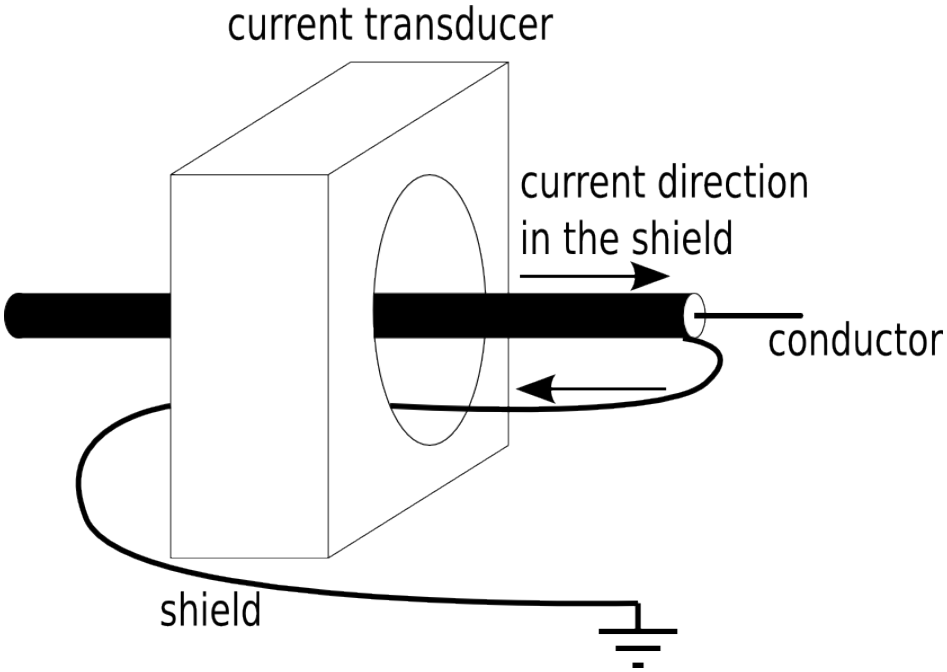

Figure 4.6: avoid measuring errors due to shield currents

4.4 Range extension by changing primary ratio at current sensors

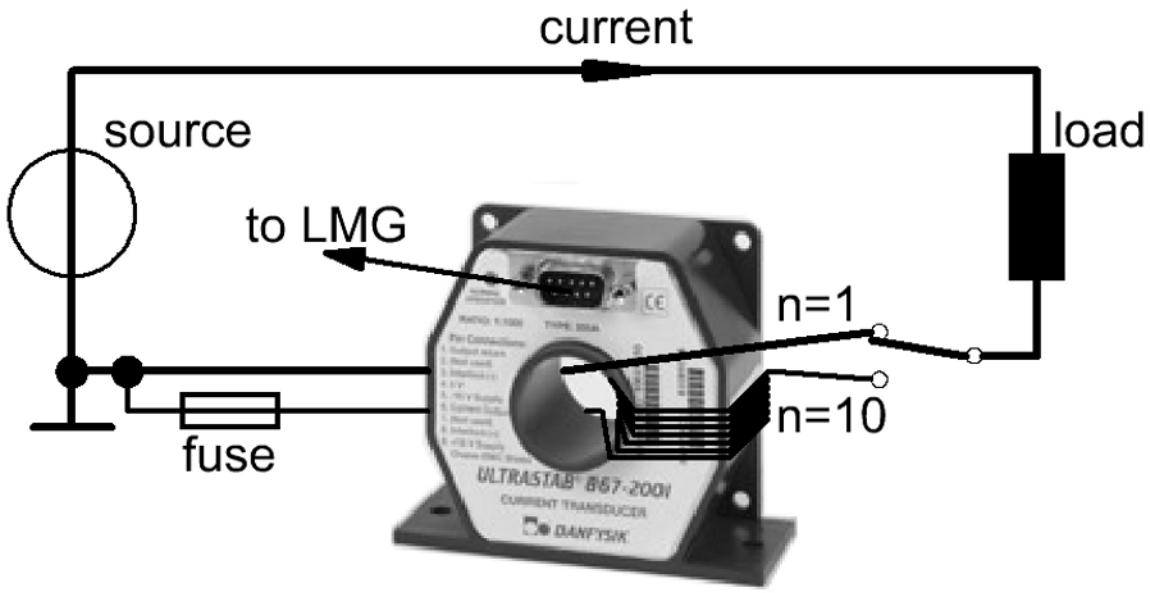

Figure 4.7: external range extension

You can use two windings through a current transducer to expand its current range.

In this example one winding with one turn (for big currents) and one winding with ten turns (for small currents) are taken. If you change the scaling value of the corresponding power meters current channel the different turns are taken into account for all of the measuring values.

This approach is suitable for all feed through and clamp on current transducers.

4.4.1 Example

- precision power meter LMG670
- current sensor PCT200
- measuring ranges (full range)
  1 turn: 2.5 A .. 200 A
  10 turns: 250 mA .. 20 A

4.5 Hints for wiring current transformers or HST to LMG

The appropriate cable types to connect the transducers to the power meter are described in this section. Each cable connects all current transformer or all voltage transducer signals from a three phase system to a power meter.

The appropriate cable types must have individually twisted pairs (TP) and a shield made of copper netting. For example, the following types of cables have the matching properties:

1. Lappkabel: Unitronic LiYCY(TP)
2. Helukabel: Paar-Tronic-CY
3. TKD-Kabel: PAARTRONIC-CY LiYCY(TP)

Use one twisted pair for one current transformer or voltage transducer. Several three phase systems can be connected together in one cable.

The cable shields are connected only on one side to the ground terminal of the high voltage divider (HST) or the current transformer. The LMG-side cable shields should remain unconnected!

4.5.1 Copper cross section

For a proper load resistor of the current transformers, use one of the following cross sections depending on the cable length. But regard also that the cable is capable to withstand the rated short-time thermal current of the current transformer!

(a) metric unit

Cable length	Copper cross section
8 m ... 12 m	$0.25\,mm^2$
11 m ... 17 m	$0.34\,mm^2$
16 m ... 25 m	$0.5\,mm^2$
23 m ... 38 m	$0.75\,mm^2$
32 m ... 51 m	$1.0\,mm^2$
48 m ... 77 m	$1.5\,mm^2$
78 m ... 128 m	$2.5\,mm^2$

(b) American wire gauge

Cable length	American wire gauge
7 m ... 10 m	AWG 24
10 m ... 17 m	AWG 22
16 m ... 27 m	AWG 20
26 m ... 42 m	AWG 18
41 m ... 67 m	AWG 16
65 m ... 107 m	AWG 14
104 m ... 170 m	AWG 12

Table 4.1: Copper cross section

For the connection of the high voltage transducer (HST) output, one does not have to care about the cross section. Coaxial cable (e.g. RG58) can be used too.

4.5.2 Treatment of the ends of the wires

Use gold-plated stackable 4mm plugs, e.g. Multi-Contact LS425-SE/M (Bürklin 15F3107) together with insulating sleeve KT425-SE (Bürklin 15F310x). Note: the 4mm plugs have to be stackable for easy LMG-side short circuit of the secondary side of the current transformers. The plated gold is important because of the contact resistance.

4.6 The burden resistor

For measurements with the specified accuracies the burden of a sensor has to be between 50 % and 100 % of the rated burden in the data sheet (at the rated frequency range). This burden can be specified as ohmic resistor or as an apparent power value. Here an example how you can convert the two values: rated secondary current = 5 A, rated burden = 2.5 VA, $R = \frac{S}{I^2} = \frac{2.5\,VA}{(5A)^2} = 100\,m\Omega$.

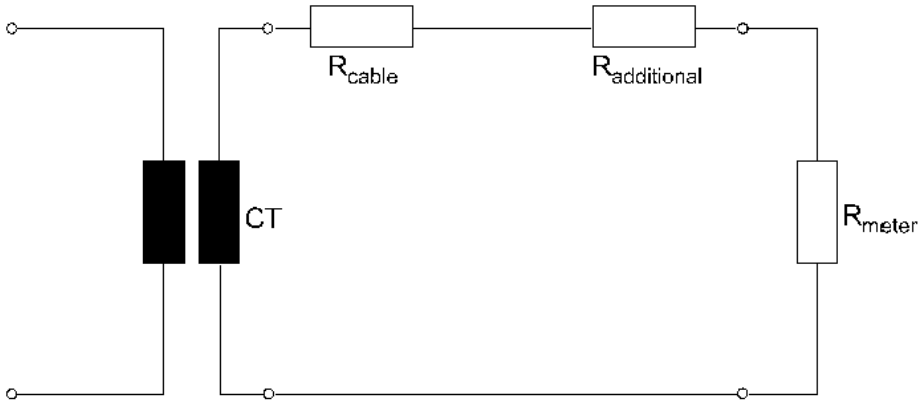

Figure 4.8: burden calculation

The burden resistor is built up from the ohmic load of the cables and additional from the burden of the meter. The sensor will not work at the specified accuracy, if the operation burden is not observed. Because of the very low input impedance of the elektronic meter inputs, the rated operation burden is mostly not reached and an additional burden resistor has to be fitted. This resistor can also be built up from a correctly dimensioned connection cabel from the sensor to the meter.

4.6.1 Example

current transformer: 100 A/5 A, rated burden 2.5 VA, operation burden = 50 %
connection cable: $l = 2\,m$, $A = 1.5\,mm^2$, copper $\rho = 0.0175\frac{\Omega mm^2}{m}$
input impedance of the power meter: $R_{meter} = 20\,m\Omega$
rated burden of the CT is: $R = \frac{S}{I^2} = \frac{2.5\,VA}{(5A)^2} = 100\,m\Omega$
operation burden of the CT is: $R_{operation} = 100\,m\Omega * 50\,\% = 50\,m\Omega$
$R_{cable} = \frac{\rho * l}{A} = \frac{0.0175\,\Omega * mm^2 * 2\,m}{m * 1.5\,mm^2} = 23.3\,m\Omega$
$R_{additional} = R_{operation} - R_{cable} - R_{meter} = 50\,m\Omega - 23.3\,m\Omega - 20\,m\Omega = 6.7\,m\Omega$

You can realize the correct burden with a larger connection cable:
$l = \frac{R * A}{\rho} = \frac{(R_{operation} - R_{meter}) * A}{\rho} = \frac{(50\,m\Omega - 20\,m\Omega) * m * 1.5\,mm^2}{0.0175\,\Omega * mm^2} = 2.57\,m$

4.7 Support request

If you need help finding the best suitable current sensors for your application, please don't hesitate to contact ZES ZIMMER, the engineers will help you. Please fill out this form and send it to +49 6171 52086 or describe the following points in an email send to sales@zes.com.

Name _____
Company _____
Street _____
City _____
Phone, fax _____
email _____
project name _____

current range lowest current to measure (Irms)? maximum current to measre (Irms, Ipk)	
overload (not to be measured, only withstand) peak current and duration? or rms current, frequency and duration?	
frequency range, bandwidth lowest frequency to measure, DC? maximum frequency to measure? you knwo about the wave shape (dc, sin, ..)? di/dt to be followed exactly (A/us)? ripple (Apkpk), ripple frequency? optionally: please provide a graphic sketch	
which **accuracy** at which current value and frequency is aspired? which **type of connection** is applicable: clamp on, feed through or terminal? min. L(mm) * W(mm) or diameter(mm)? any other mechanical requirements?	
are there restrictions on the **inserted impedance** in the current path?	
at which **working voltage** does the current sensor operate: working voltage against earth (Urms, Upk, CAT, frequency)? nominal voltage between phases? current measurement at low voltage return or at high voltage potential? dU/dt applied on primary?	
which type of **application** will be measured?	
you know the approximately **power factor**?	
with wich **type of power meter**? other instrument?	
environmental conditions: temperature range? degree of pollution?	
additional requirements? comments?	